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STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

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STATE GEOLOGICAL SURVEY

M. M. LEIGHTON, *Chief*

BULLETIN NO. 47

GEOLOGY AND MINERAL RESOURCES OF THE EQUALITY-SHAWNEETOWN AREA

(Parts of Gallatin and Saline Counties)

BY
CHARLES BUTTS

WORK IN COOPERATION WITH THE U. S. GEOLOGICAL SURVEY

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LETTER OF TRANSMITTAL

State Geological Survey Division,
September 1, 1925

A. M. Shelton, Chairman, and Members of the Board of Natural Resources and Conservation:

Gentlemen: I have the honor to transmit herewith the manuscript and maps for the printing of Bulletin No. 47, entitled "Geology and Mineral Resources of the Equality-Shawneetown Area," including parts of Gallatin and Saline counties, by Charles Butts. This investigation, designed to promote a more intelligent recovery and conservation of the mineral resources of the area mentioned, and to provide the citizens of that community and others who are interested with authoritative educational information regarding that region, was instituted by my predecessor, Mr. F. W. DeWolf, and the work was undertaken and completed in cooperation with the U. S. Geological Survey.

Respectfully yours,

M. M. LEIGHTON, *Chief.*

GEOLOGY AND MINERAL RESOURCES OF THE EQUALITY-SHAWNEETOWN AREA

(Parts of Gallatin and Saline Counties)

By Charles Butts

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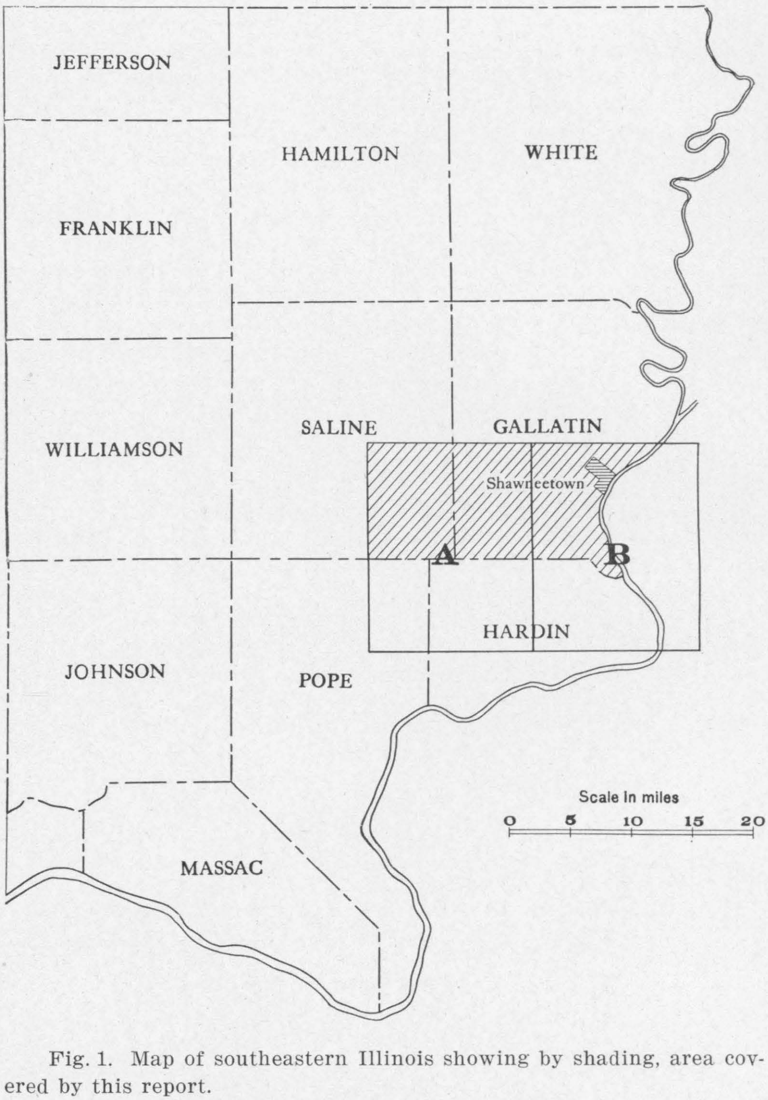

Fig. 1. Map of southeastern Illinois showing by shading, area covered by this report.

A. Equality quadrangle.

B. Shawneetown quadrangle.

CHAPTER I—INTRODUCTION

Location

The Equality and Shawneetown quadrangles are located mainly in southeastern Illinois, but the Shawneetown extends eastward across Ohio River into western Kentucky. They are bounded by the parallels of latitude 37° 30′ and 37° 45′ N. and the meridians of longitude 88° 00′ and 88° 30′ W. Each quadrangle comprises one-sixteenth of a square degree, the area of which in this latitude is 236.5 square miles. The location of the quadrangles is shown on the index map (fig. 1). The parts of the quadrangles covered by this report are in southern Gallatin and southeastern Saline counties and include the Eagle Valley coal field.

Topographic Relations

General character of the surface

Most of the area covered by this report is hilly, but large areas of flat bottomland border Ohio and Saline rivers. The lowest part of the quadrangles is on Ohio River, where the usual water level is about 320 feet above sea level. The highest points are Cave Hill, 950 feet above sea level, in sec. 3, T. 10 S., R. 7 E., and Horton Hill, 980 feet above sea level, located in sec. 28, T. 10 S., R. 7 E., about 2 miles southeast of Somerset. The extreme relief is, therefore, 660 feet.

The most striking surface feature is the U-shaped ridge opening eastward enclosing Eagle Valley, the summits of which are 500 to 550 feet above the flat land along the streams. On the west this ridge culminates in Cave Hill, on the north it is known as the Wildcat Hills and Gold Hill, and on the south as Karbers Ridge. In Eagle Valley are a number of low hills and ridges, such as Maher Hill and north of the Wildcat and Gold Hills are other low hills rising like islands above the general expanse of flat lands, such as the Shawneetown Hills, the hill on which Equality is located, the hill west of Equality, and a number of low hills and ridges in the area from West Big Ridge to Somerset. The wide areas of very flat land at an elevation of about 380 feet are in strong contrast to the hills which surround them. They owe their peculiar character to the filling of temporary lakes that occupied these valleys in the latest stages of the glacial epoch.

The surface of the hilly part of the area is very closely dissected by the streams into small hills, narrow ridges, and short spurs generally with low rounded crests. So completely is the surface of the country cut up by the streams that it is only along a few ridges between the headwaters of the streams that roads can be located without continuously crossing hollows and steep-sided valleys. In but few places in the hills can roads follow a straight course for more than a mile without having to cross a ridge or valley.

STREAM CHANNELS AND FLOOD PLAINS

The larger streams, and especially Ohio, Tradewater, and Saline rivers, have entrenched their beds 20 to 30 feet below the level of the highest flood. The minor streams have also produced similar features in their courses. The larger streams are bordered by steep, and in part, perpendicular banks, 20 to 30 feet high, of the alluvial material of which the bottoms are composed.

DRAINAGE

The quadrangles are drained through Ohio River, which crosses the Shawneetown quadrangle, into Mississippi River and thence into the Gulf of Mexico. The drainage system, consisting of a main trunk river and its various tributaries, is well developed, extending to all parts of the quadrangles and leaving no undrained areas, except a few lakes and swamps east of the Shawneetown Hills and southeast of Saline Mines. Besides the Ohio, Saline River, with its various branches, and Eagle Creek are the main streams, the first draining the northern part of the quadrangles and the second draining Eagle Valley. The grade of the streams is low. Saline River falls about 20 feet in 30 miles, or about 7 inches per mile.

On the flood plains of Ohio River there are several narrow lakes or ponds, elongated in the direction of the river. Of these Big Lake, Fish Lake and Mud Lake are examples. They occupy parts of abandoned channels of the river, which has shifted its course from time to time.

Relations of Man to Topography

There is a very intimate relation between topography and human activities. A few of the ways in which this relation is manifested will be pointed out. The main lines of human travel and migration are, and always have been, in very obvious ways largely controlled by topography. A mountain pass like Cumberland Gap, or a strait like the Dardanelles, has exerted a profound influence on the course of human history. Great cities are located on and at the intersection of these main natural lines of travel determined by topography. Topography largely controls the location of railroads. Level and gently rolling lands have ever invited settlement, and from the earliest recorded times have been the most thickly populated parts of the earth and the centers of civilization. On the other hand, rough or mountainous countries have always been thinly populated, and as a consequence the people are likely to be backward in the arts of civilization, but self-restraint, independent, and zealous of their freedom. As a result mountain people are prone to be a law unto themselves, and much less submissive to the restraint of civil laws than are the dwellers on populous plains.

Culture

Probably five-sixths of the Shawneetown and two-thirds of the Equality quadrangle have been cleared and are in pasture or cultivation. The forested parts are the hills, such as Cave Hill and Gold Hill, or the steep slopes, or the deep ravines. Considerable tracts of forest still remain on Ohio River flats, in a belt 2 miles or more wide adjacent to the river, extending from Saline River to the north boundary of the Shawneetown quadrangle.

The population of the quadrangles is mostly rural: Shawneetown is the largest town; Equality is the second town in size. Other towns of smaller size are Junction, Somerset, Rudiment and Saline Mines.

Wagon roads are adequately distributed throughout the area. Most of them are passable by automobiles, though their condition in general is far from satisfactory.

Most of the area is distant from railroads. A branch of the Louisville and Nashville Railroad, however, passes through Equality. Both this branch and a branch of the Baltimore and Ohio Railroad, extend to Shawneetown, where they connect with river transportation. A branch of the Illinois Central Railroad extending from Princeton, Kentucky to Evansville, Indiana also passes through the eastern part of the Shawneetown quadrangle in Kentucky and is accessible to the adjacent parts of Illinois. Another branch of the Illinois Central Railroad extends to the Stewart fluorspar mine, about 2 miles south of the Equality quadrangle and half a mile east of the Pope-Hardin County line. The Cleveland, Cincinnati, Chicago and St. Louis Railroad passes through Harrisburg, about 3 miles west of the Equality quadrangle.

CHAPTER II—DESCRIPTIVE GEOLOGY

General Statement

The rocks outcropping in the area covered by this report range in age from Upper Devonian or possibly basal Mississippian, nearly to the top of the Pennsylvanian. They include strata of limestone, sandstone and shale. These strata are divided into formations, the succession, thickness, general character, and classification of which are shown in the generalized columnar section (Pl. I). Besides these sedimentary rocks there are probably present small bodies of igneous intrusives, in the form of plugs, dikes, and sills, injected in a molten condition into the sedimentary strata. The sedimentary strata are mostly of marine origin, and were originally deposited in an approximately horizontal attitude. They are not now horizontal, however, but are inclined at varying degrees of steepness, as shown in the profile sections on the geological map. The various formations are described in ascending order, beginning with the lowest and oldest—the order of their deposition.

Stratigraphy

DEVONIAN SYSTEM

The Devonian system is certainly represented in this area by a considerable thickness of limestone, and probably by the greater part if not the whole of the overlying black shale, although the Devonian age of that shale is questioned by E. O. Ulrich and others. The Devonian limestone does not outcrop in the area, but probably lies at no great depth beneath the lake beds just north of the small area of the black or Chattanooga shale at the north base of the knob in the north central part of sec. 36, T. 9 S., R. 7 E., shown on the detail map, Plate II.

DEVONIAN OR MISSISSIPPIAN SYSTEM

CHATTANOOGA SHALE

Name.—A widespread black shale formation extends throughout large parts of the following states: Michigan, Ohio, Kentucky, Tennessee, Alabama, Georgia, Indiana, Illinois, southern Missouri, Arkansas, and Oklahoma. For this shale the name Chattanooga is in general use in most of the areas lying south of Ohio River and extending as far west as Oklahoma.

This name is not the earliest one proposed for the formation, but is rather one of the later ones; however, it has been more widely applied than any other and may be adopted for this area, although the name Ohio shale has priority and in the writer's opinion should be used.

Distribution.—The Chattanooga shale outcrops only in a very small area on the north side of the knob one-half mile northwest of Horseshoe, (Pl. I).

Character.—The Chattanooga is a black, carbonaceous, fissile shale, with occasional non-fissile layers a foot or more in thickness. In some parts of the formation small amounts of pyrite are present, together with a few very hard, concretionary bodies that are more or less pyritiferous. Upon weathering, the shale loses its deep black color, becoming brownish, and finally grayish in color, and splits readily into thin, laminar fragments.

Thickness.—The thickness of the Chattanooga in the region, which has been underestimated in previous accounts at 50 to 100 feet, is actually about 400 feet.

Fossils.—The Chattanooga shale in Hardin County to the south, is almost devoid of fossils. Mr. Weller has, however, found a single specimen of the Phyllocarid crustacean *Spathiocaris,* very similar to or identical with *Spathiocaris emersoni* Clarke from the Upper Devonian Portage formation of New York. Examples of a species identical with the form in the Chattanooga shale in Hardin County have been collected by Weller in the Sweetland Creek shale of Iowa and in a greenish shale overlying the black shale in southwestern Missouri. There have also been obtained from the top a brachiopod shell, probably a *Leptaena* or *Pholidostrophia,* a fragment of a shell suggesting a *Bellerophon,* and a plumose, carinated fragment suggestive of a conodont or the fringed tip of a crustacean spine, like the telson spine of *Acanthotelson eveni.*

Correlation.—The Chattanooga shale of Hardin County is supposed to include the equivalent of the Chattanooga of the type locality—Chattanooga, Tennessee—but it must include much more than that, for at Chattanooga the shale is only 20 to 30 feet thick. From Chattanooga this characteristic black shale has been traced practically all the way to Hardin County, notwithstanding it is concealed by overlying formations over extensive areas. It, however, everywhere appears in outcrop wherever its horizon is exposed, so that there is no doubt whatever of its continuity as a great sheet spread over the entire region from Birmingham, Alabama, northwestward to the Mississippi Valley. Ulrich thinks the main body of the black shale in Ohio, and at New Albany, Indiana, is Mississippian and equivalent to the Kinderhook of the Mississippi Valley, although admitting that the lower few feet is of Devonian and probably of Genesee age. In this region it lies between limestone of Middle Devonian (Hamilton) age below, and limestone of Osage age above, and might, therefore, be either Upper Devonian (Genesee, Portage, Chemung) or lower Mississippian (Kinderhook), or it may be partly one and partly the other.

MISSISSIPPIAN SYSTEM

GENERAL STATEMENT

All the post-Chattanooga formations of the area, except some unconsolidated superficial deposits of geologically recent origin, belong to the Mississippian and Pennsylvanian systems.

The Mississippian system is named from the Mississippi Valley, in which region it is most fully developed. In southeastern Illinois and adjacent areas the Mississippian rocks are divided as follows:

TABLE 1.—*Table showing the subdivisions of the Mississippian system.*

Chester group
- Kinkaid limestone
- Degonia sandstone
- Clore limestone
- Palestine sandstone
- Menard limestone
- Waltersburg sandstone
- Vienna limestone
- Tar Springs sandstone
- Glen Dean limestone
- Hardinsburg sandstone
- Golconda formation
- Cypress sandstone
- Paint Creek formation
- Bethel sandstone

Grouping in dispute:
- Ste. Genevieve limestone:
  - Ohara limestone member[1]
  - Rosiclare sandstone member
  - Fredonia oolite member

Meramec group:
- St. Louis limestone
- Spergen limestone
- Warsaw limestone

Osage group:
- Keokuk limestone } Not differentiated in these quadrangles.
- Burlington limestone }

Kinderhook group (absent in these quadrangles?).

Chattanooga shale (Mississippian or Devonian).

The outcrops of the Chattanooga shale and the Mississippian system in the area covered by this report are nearly confined to the fault blocks

[1] The upper three-fourths of the Ohara is by all assigned to the Chester group. Prof. Weller identifies the upper Ohara as the same as the Renault formation of the Mississippi Valley, and calls the lower part of the upper Ohara the "Shetlerville formation". Weller, Stuart, Geology of Hardin County: Ill. Geol. Survey Bull. 41, 1920.

and steeply upturned belts at the north end of Cave Hill and the northern slope of Wildcat Hills. Limestone is reported to outcrop also at the north base of Gold Hill, but none was observed. There is a very small area of uppermost Mississippian exposed on the south boundary of the area, between High Knob and Buzzards Point, near the southwest corner of Gallatin County, and an area exposing the three upper formations of the Mississippian on the Horton Hill anticline, in the southeast part of Saline County. Owing to the thinness of the formations of the Chester group, their steep dip and poor exposure in the fault blocks and other areas mentioned, they have not been mapped separately in those areas, except the Clore and Kinkaid limestones, but their entire area is mapped as "undivided Chester formations". The individual formations in the fault blocks are mapped on the large scale detail map, Plate II.

OSAGE LIMESTONE

Name.—The name Osage was first applied by Williams[2] from Osage River, Missouri. The name "Tullahoma formation" was applied by Bain[3] to the limestone in this region, but the name is inapplicable, as the Warsaw limestone was included in the "Tullahoma formation" of Tennessee. As here defined, the Osage limestone of these quadrangles includes the full thickness of rocks between the Chattanooga shale below and the Warsaw limestone above.

Distribution.—The Osage limestone outcrops only in a small area on the knob half a mile northwest of Horseshoe Gap, 3 miles southwest of Equality (Pl. II).

Character.—The Osage limestone in exposures is almost exclusively a chert, bedded in layers up to one foot thick. The chert has some distinctive characters, generally being grayish, yellowish, or bluish elongated fragments, with rudely triangular cross sections and with smooth lateral faces. Much of it is also finely color-banded, in gray, pink, or yellow, the bands being either concentric, as in some of the loose pieces, or parallel with the bedding, as in the chert layers in place. In texture the chert ranges from compact, brittle, or tough, through somewhat porous and tough to finely porous and somewhat friable. Some of the hard, dense, chert seems to be minutely cracked, so that it may be shattered easily into small angular fragments. A notable characteristic of these Mississippian cherts is the almost total absence of fossils, which is a great contrast to the chert of similar

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[2] Williams, H. S., Correlation papers: Devonian and Carboniferous, U. S. Geol. Survey Bull. 80, p. 169, 1891.
[3] Bain, H. F., The fluorspar deposits of southern Illinois: U. S. Geol. Survey Bull. 255, p. 19, 1905.

age elsewhere in the Mississippi Valley region, where much of it is crowded with crinoid plates and other fossils. A few isolated stem plates of crinoids and a very few other fossils, have been observed in Hardin County, to the south, but most of the chert is entirely without fossils of any sort. The finely porous, more friable chert resembles a fine-grained sandstone, and may have been originally a siliceous limestone in which the silica occurred in the form of very fine quartz grains.

Although the Osage manifests itself on the surface as chert, this chert is quite likely only a superficial development, and the formation is probably a true limestone below the depths to which water and air have had free access and circulation—in other words, below the zone of active weathering. Such superficial change of limestone to chert, by the solution of the carbonate of lime and the deposition of silica in its place, is a common process in nature. The only direct evidence, however, that the Osage is essentially limestone in its original condition, is the outcrop of fine-grained black limestone, about ten feet thick, in the bank of Goose Creek in sec. 32, T. 11 S., R. 8 E. in Hardin County. At this locality the change from the limestone to chert upward from the creek bed is exhibited. There is no evidence of any shale in the formation as was asserted by Bain.[3]

Thickness.—The only locality in this general region where an estimate of the thickness of the Osage can be made is on Hicks Branch in SW. ¼ sec. 25, T. 11 S., R. 7 E., Hardin County, where the formation is fully exposed. The width of the outcrop at this locality is 2,000 feet, and the average dip is 16° SW., computed from 17 independent measurements well distributed across the outcrop, which makes the thickness 550 feet, this being the best estimate that can be made under the conditions, and being nearly three times as great as that recorded by Bain.[3] It seems to be about the same thickness in exposure near Horseshoe in this area, where it is nearly vertical and its thickness about the same as the width of its outcrop.

Fossils.—As already stated, the Osage in this region is nearly unfossiliferous in great contrast to its character in the Mississippi Valley and to corresponding rocks in Alabama and eastern Tennessee. A possible explanation of the fact may be that the crinoids, bryozoa, and brachiopods, so abundant in the Osage and its equivalent elsewhere, were especially adapted to life in shallow, warm water, such as doubtless existed generally throughout the Osage sea. This region may have been a deeper depression of the sea floor, where the water was too deep for the animals to live upon the bottom, and into which their hard parts were not washed by currents from shallow water. The few fossils that have been collected from the forma-

[3] Bain, H. F., The fluorspar deposits of southern Illinois: U. S. Geol. Survey Bull. 255, p. 19, 1905.

tion, as the result of constant vigilance and persistent search, are listed below:

List of fossils from the Osage limestone

Productus burlingtonensis Hall?	Solenomya? sp.
Productus setigera Hall	Sphenotus? sp.
Rhynchopora? sp.	Phanerotrema? sp.
Aviculopecten sp.	Griffithides sp.
Posidonomya? sp.	

Most of the material, as appears from the list, is too poorly preserved for even certain generic identification, although there is probably but little ground for doubt on that point. There is nothing especially significant for stratigraphic determination in the list. All the genera are known to occur in the Osage, and most of them have a longer range, but none of the forms recorded throw any light upon the depth of the water or other conditions in the region during Osage time.

Correlation.—The Osage limestone of this region occupies the same position between the Chattanooga shale and the Warsaw limestone as do the Burlington and Keokuk limestones of the Mississippi Valley; also the same position above the Chattanooga shale as the Fort Payne of middle Tennessee and Alabama. Moreover, the Fort Payne of Tennessee and Alabama is by its fossils to be correlated with the Keokuk limestone at least, and it possibly includes beds equivalent to some part or all of the Burlington limestone, so that there seems to be no reason to doubt the correctness of the correlation of the Osage of this region with the Fort Payne to the east and the Keokuk and Burlington to the west. Its thickness, however, is much greater than that of the Fort Payne, and is about the same as that of the Osage group of southern Indiana and the Louisville region of Kentucky, which is composed of the New Providence shale below, the Kenwood sandstone in the middle, and the Rosewood shale and Holtsclaw sandstone above, aggregating 600 feet. On the other hand the Osage of this region is much thicker than the Keokuk and Burlington limestones of the Mississippi Valley, which have a maximum combined thickness of only 225 feet. From these circumstances it appears reasonable to suppose that the Osage of this region includes the equivalents of both the Keokuk and the Burlington.

However, there is one item of evidence tending to show that the Osage of Hardin County includes only beds of Keokuk age and is nearly equivalent to the Fort Payne chert. Near the north entrance to Horseshoe Gap three miles southwest of Equality, the Osage outcrops on a conspicuous knoll and is the same in character and thickness as in Hardin County. Below the Osage at this locality the Chattanooga shale also outcrops as revealed by fragments of the characteristic, black, fissile shale; but between the Chattanooga and the Osage is a few feet of dark, irregularly fissile shale with peculiar curly markings like worm trails. Now these peculiar markings are characteristic of the Rosewood shale of the Louisville region, Kentucky, of determined Keokuk age. They are widely distributed throughout all the region from Crawfordsville, Indiana, to Overton and Davidson counties, Tennessee, where they invariably occur in shale which is everywhere, by all criteria, to be correlated with the Rosewood. In other words, such evidence as is known indicates that the Osage chert at the locality described above, has beneath it shale of Keokuk age and therefore includes no component of Burlington age, and the condition in Hardin County would presumably be the same.

WARSAW AND SPERGEN (?) LIMESTONES

Name and distribution.—Throughout the Mississippi Valley, wherever the Osage is present, it is overlain by the Warsaw formation. The Warsaw is also present in southwestern Indiana and adjacent parts of Kentucky, where it has been called the "Harrodsburg limestone", and it extends southward across Kentucky and Tennessee and into northern Alabama. In this the Warsaw outcrops only on the south side of the knoll half a mile northwest of the Horseshoe Gap, 3 miles southwest of Equality.

Character.—Approximately the lower three-fourths of the beds under consideration as exposed on Hicks Branch, in Hardin County, is without doubt of Warsaw age. It is a dark to black, fine-grained somewhat cherty and sparingly fossiliferous limestone in layers a foot or two thick. The upper one-fourth, which may be of Spergen age, contains a considerable proportion of coarse grained, light gray limestone in thick layers, intercalated with which are layers of shale and layers of dark, shaly-weathering limestone. The Warsaw is hardly different lithologically from much of the overlying St. Louis limestone. On long continued weathering near the surface, it is largely silicified to brittle, fossiliferous chert, which can be distinguished from the similarly bedded Osage chert by its rather plentiful fossils, while the Osage chert is essentially non-fossiliferous.

Much of the upper coarse, light gray limestone (Spergen?) on extreme weathering becomes very rough, by reason of the projecting fragments of fossils, and is altered to a coarsely porous, reddish chert resembling a red rubber sponge. Dense, platy, fossiliferous gray chert also occurs.

Thickness.—As deduced from the dip and width of outcrop on Hicks Branch, in Hardin County, in the SW. ¼ sec. 25, T. 11 S., R. 7 E., the Warsaw and Spergen (?) limestones are 250 feet thick. In only one other section known to the writer—that at Colesburg, Kentucky—is this thickness equalled.

Fossils.—Fossils are fairly abundant in the Warsaw and Spergen (?) limestones, although few are well preserved. Most of them occur in the

[1] It is now known that these markings also occur abundantly in the sandy facies of the New Providence formation in eastern Kentucky which is regarded as of Fern Glen and lower Burlington age.

Spergen (?), which is characterized by the coarse grained, light gray limestone, but in addition to these much of the limestone throughout the mass is crowded with fenestellid bryozoans. As a general rule, the fossils are revealed to view in condition for identification only in the chert. A list of the species that have been identified is as follows:

List of fossils from the Warsaw and Spergen (?) limestones

Triplophyllum, a small slender species; common
Pentremites conoideus Hall
Platycrinus, rather large species with oval, spiny stem plates ½-inch in diameter or larger; common; entire bases indicating heads ½ to 1 inch in diameter occasionally found.
Cystodictya lineata Ulrich
Cystodictya pustulosa Ulrich
Dichotrypa lyroides Ulrich?
Fenestella tenax Ulrich
Hemitrypa proutana Ulrich
Lyropora sp.
Polypora simulatrix Ulrich
Athyris densa Hall; common
Brachythyris suborbicularis (Hall)?
Brachythyris subcardiiformis (Hall)?
Camarotoechia mutata (Hall)?
Cleiothyridina hirsuta (Hall)
Eumetria verneuiliana (Hall)
Rhipidomella dubia (Hall)
Spirifer bifurcatus Hall
Spirifer lateralis Hall
Spirifer tenuicostatus Hall; common
Spiriferina subtexta White?

Correlation.—Several of the species recorded in the foregoing list are known elsewhere only from the Warsaw and Spergen limestones. Such are *Pentremites conoideus, Athyris densa, Brachythyris subcardiiformis,* and *Spirifer lateralis.* These forms characterize the Warsaw from Illinois through Kentucky and Tennessee to the Birmingham district, Alabama. *Athyris densa* has been recorded as a Spergen limestone fossil, but the original specimens were collected in Indiana and Kentucky, from beds that are now known to be Warsaw. *Spirifer lateralis* is not known below the Warsaw, nor is it reported from above the Spergen. *Polypora simulatrix* is reported from the Keokuk and Warsaw, but not from higher beds. Altogether the assemblage seems to be characteristic of the Warsaw. As already stated, it is possible that the upper fourth of the 250 feet of limestone here described, that is, the part with the coarse, light gray, fossiliferous layers is of Spergen age. In fact, it is the writer's opinion that the Spergen limestone is a local facies of the upper half of the Warsaw limestone, this facies being typically developed in Indiana. While the Spergen carries the Warsaw fauna it carries also a peculiar and distinctive fauna of its own, and although it is believed to be represented in this region, the characteristic Spergen fauna and type of rock are wanting.

ST. LOUIS LIMESTONE

Name and limits.—The St. Louis limestone has received its name from St. Louis, Missouri, where it is typically developed. In this area its lower boundary is determined partly by fossils and partly by change of lithology.

As mentioned in the description of the Warsaw and Spergen (?) limestones, the upper part of those rocks carries beds of coarsely crystalline, light gray limestone yielding a spongy red chert and carrying a fauna with *Pentremites conoideus, Athyris densa,* and other characteristic Warsaw species that do not occur in higher beds. Close above these beds is dark, finely crystalline limestone carrying *Lithostrotion proliferum* and probably rare specimens of *L. canadensis,* both being characteristic of the St. Louis. The basal St. Louis boundary lies between the two groups of strata, and under favorable conditions can be determined within 20 feet of its time location. The same paleontologic criteria hold throughout the entire extent of the formations in Kentucky, Indiana, Tennessee, and Alabama, and are associated with lithologic criteria even more decisive than those in southeastern Illinois. After several seasons of field work, and with attention purposely directed to the matter, no single occurrence of any of the typical Warsaw forms listed in the same layers with *Lithostrotion proliferum* or *L. canadensis,* or above the lithologic boundary recognized, has been observed, although the Warsaw forms in many places occur not far below and the St. Louis fauna not far above that boundary.

Distribution.—There are two areas of outcrop of the St. Louis, both in the fault blocks southwest of Equality, one being a strip about 1¼ miles long lying immediately west and northwest of Horseshoe Gap, and the other a very small area near the center of the SW. ¼ sec. 34, T. 9 S., R. 7 E., where *Lithostrotion proliferum* occurs in limestone exposed in a roadside ditch a few rods northwest of a spring (Pl. II).

Character.—Owing to poor exposures in the area here described, the description of the St. Louis is drawn mainly from exposures in Hardin County, to the south. In its general characters the lithologic features of the St. Louis limestone are similar throughout the entire area of its distribution. In southern Illinois, where it is not notably different from other localities, the upper 75 to 100 feet is in the main gray, bluish-gray, or blue, while a large part of the lower 250 to 300 feet is dark or nearly black limestone for the most part in even beds from a few inches to several feet thick. In the river sections half a mile west of Cave in Rock, in sec. 13, T. 12 S., R. 9 E., the bluish-gray layers constitute the upper 75 feet, while the 200 feet below, exposed to the west along the river, is predominantly dark-gray or black, dense, and fine-grained, a few layers being nearly as fine-grained as lithographic stone. Other layers are more granular and some are coarsely crystalline. No oolitic rock has been recognized. Most of the rock is hard and tough, but that of lithographic texture is brittle and breaks with a conchoidal or splintery fracture. Much of the limestone of the formation contains considerable amounts of chert, occurring commonly as lenticular or irregular masses distributed along horizontal lines parallel with the bedding planes, being more abundant near the surface and still more conspicuous in the residual deposits remaining after the decomposition of the limestone. It is clearly of secondary origin, being formed by the replacement of limestone by silica.

Thickness.—The thickness of the St. Louis in this area is about 350 feet, which is approximately the thickness at St. Louis, Missouri, but considerably greater than the thickness in Ste. Genevieve County, Missouri, where it is less than 100 feet, or in southeastern Indiana.

Fossils.—The most common fossils of the St. Louis in this general region are *Lithostrotion canadensis* and *Lithostrotion proliferum*. The latter is abundant in some layers throughout the entire formation. A good exhibition of one of these layers near the top is along Hicks Branch, in sec. 23, T. 11 S., R. 7 E. Another bed, about 75 feet below the top of the St. Louis, crowded with large heads, is exposed along Ohio River about three-fourths of a mile west of Cave in Rock in Hardin County. Within the area covered by this report *Lithostrotion proliferum* was found only in the small area of St. Louis near the center of sec. 34, T. 9 S., R. 7 E. *L. canadensis* is a less abundant species, which appears to be more prevalent in the upper than in the lower part of the St. Louis. Both are, so far as known in this part of Illinois and eastward through Kentucky, confined to the St. Louis limestone. The most common manner of occurrence of these fossils is in the form of loose silicified specimens in the residual chert scattered on the surfaces underlain by the St. Louis.

At the locality west of Cave in Rock, described above, there are associated with the *Lithostrotion*-bearing bed layers carrying a considerable number of other fossils. There are one or two species of Spirifer, one *S. bifurcatus; Camarotoechia mutata;* a Productus, abundant; a Dichotrypa with large foliaceous expansion 18 inches across; a Polypora; a slender ramose bryozoan; a Platycrinus like *Platycrinus penicillus;* a small zaphrentid coral like *Triplophyllum calcariformis;* and a few small specimens of a pyriform Pentremites.

Correlation.—The fossils, character, and stratigraphic relations of the limestone described leave no doubt that it is correctly identified as St. Louis. That determination seems never to have been questioned.

UNCONFORMITY AT TOP OF ST. LOUIS LIMESTONE

In parts of Missouri and in eastern Kentucky and Tennessee there is clearly an erosional unconformity between the St. Louis and the overlying Ste. Genevieve limestones. The unconformable contact is exposed along Kentucky River, 3 miles west of Heidelberg, Kentucky; and from Burnside, Kentucky, to Mt. Vernon, Kentucky, the basal layers of the Ste. Genevieve, for a distance of 1 to 3 feet above the contact, contain abundant angular fragments of black chert evidently derived from the top layers of the St. Louis, which carry many nodules of black chert and in which both species of Lithostrotion are common. South of Ste. Genevieve, Missouri, pebbles of apparently crystalline rock and, to the southwest of St. Marys, Missouri, silicified Devonian fossils occur near the contact. Throughout most of its extent the basal layers of the Ste. Genevieve in contact with the St. Louis are oolitic, but along Ohio River, as in the vicinity of Elizabethtown and Cave in Rock, there is a considerable thickness of thin-bedded, light-gray, cherty, non-oolitic limestone between the St. Louis and the overlying typical oolitic limestone of the Ste. Genevieve. These beds are unlike the St. Louis, and in their non-oolitic character are unlike typical Ste. Genevieve. They are unmistakably linked to the latter, however, by their fossils, such as *Platycrinus penicillus,* of which large stem plates are fairly abundant, and a fairly abundant Spirifer, which appears to be *Spirifer pellaensis,* both forms being regarded as characteristic of the Ste. Genevieve. Wherever the St. Louis is overlain by the oolitic Ste. Genevieve beds in this region the non-oolitic basal beds exposed along Ohio River are believed to be absent, and their absence is another evidence of slight elevation producing a break in sedimentation between the St. Louis and Ste. Genevieve.

STE. GENEVIEVE LIMESTONE

Name and definition.—The Ste. Genevieve limestone was so named by B. F. Shumard in 1857, from Ste. Genevieve, Missouri, on Mississippi River about 50 miles south of St. Louis. It lies between the St. Louis limestone below and the Bethel sandstone above. In this locality the Ste. Genevieve includes any beds equivalent to the Ohara limestone member of Ulrich or of the Renault and Shetlerville formations of Weller that may be present but not recognizable in the fault blocks at the north end of Cave Hill, 5 miles southwest of Equality. The Rosiclare sandstone is also included if present, but the formation in this area appears to be represented chiefly if not wholly by the Fredonia oolite member of Kentucky.

Distribution.—There is a narrow strip of outcrop of Ste. Genevieve at the north foot of the Wildcat Hills, 2 miles south of Equality; another strip in the faulted block just west of Horseshoe Gap (Pl. I); and a third narrow strip in the SW. ¼ sec. 34, T. 9 S., R. 7 E. (Pl. II).

Character.—The lower 50 feet of the Ste. Genevieve in this general region is composed of rather thin-bedded, non-oolitic, cherty limestone, well displayed on the river bluff at Elizabethtown and east of Cave in Rock, Hardin County. The part overlying the beds just described is a massive limestone of gray, blue-gray, or nearly white color, predominantly oolitic, but including layers of dense, compact limestone, which exhibit a conchoidal or splintery fracture, not unlike some of the layers of the underlying St.

Louis. The most notable feature is the white oolite, nearly pure calcium carbonate, which makes up the greater part of the upper three-fourths of the formation, some of the oolitic layers being distinctly cross-bedded. So far as exposed in this region it is a thick-bedded, gray oolite fully comparable to the main body of the formation elsewhere.

On weathering the formation yields a large amount of chert, the areas underlain by it being strewn with generally small pieces of chert. In the upper part, the chert is apparently secondary and residual only, not occurring in the layers, but in the lower 50 feet of thin-bedded, non-oolitic limestone it is developed on the weathered edges of the exposed limestone, which it penetrates to the depth of an inch or two.

The chert from the oolitic layers of the member preserves the oolitic structure perfectly, and by that character can be surely distinguished from the chert of the underlying St. Louis limestone which is invariably non-oolitic.

Fossils.—Fossils are fairly abundant in the Ste. Genevieve. The diagnostic forms as identified by Weller, are listed below:

Pentremites pinguis Ulrich
Pentremites princetonensis Ulrich
Pentremites pulchellus Ulrich
Mesoblastus glaber (Meek and Worthen)
Platycrinus penicillus (Meek and Worthen)
Platycrinus huntsvillae (Wachsmuth and Springer)
Dizygocrinus persculptus Ulrich
Productus parvus (Meek and Worthen)
Pugnoides ottumwa (White)
Spirifer pellaensis Weller

The forms listed are confined practically to the Ste. Genevieve throughout its known extent, from Mississippi Valley to eastern Kentucky, and are also found in the Newman limestone of southwestern Virginia and in the Bangor limestone of northwestern Georgia. *Platycrinus penicillus,* the main guide fossil for the formation, has been found at the salt spring in the southeast corner of sec. 27, T. 9 S., R. 8 E., 3 miles southeast of Equality, about 1 mile west of Horseshoe Gap, and near the center of sec. 34, T. 9 S., R. 7 E. There can be no doubt that the limestone of these areas is correctly identified as Ste. Genevieve.

BETHEL AND CYPRESS SANDSTONES

Name.—The Bethel sandstone was named by Butts, from Bethel School, Crittenden County, Kentucky, one of the places where it is fully exposed and reaches its maximum thickness. The Cypress sandstone was named by Englemann, from Cypress Creek, Union County, Illinois. Throughout most of their extent these formations are separated by the Paint Creek formation or the Gasper oolite, neither of which however, is known to be present in this area, so that the two sandstones constitute essentially one unit.

Distribution.—The Bethel and Cypress sandstones outcrop in the fault blocks at the north end of Cave Hill, and supposedly in the area of undivided Chester formations along the north slope of the Wildcat Hills. They make the high ridge extending east and west just north of the middle of secs. 35 and 36, T. 9 S., R. 7 E.

Character.—The Bethel and Cypress sandstones are fine-grained, massive, and compact, and commonly more or less irregularly cross-bedded. They are rather uniform in texture, although locally a few streaks of quartz pebbles the size of peas have been observed in the Bethel. The weathered surfaces are yellow, yellow-brown, or reddish-brown locally. Unweathered surfaces of the rock, when freshly broken, are lighter colored than the long exposed surfaces, in some places being nearly white.

Thickness.—The combined thickness of the sandstones in this region is not less than 200 feet.

Correlation.—Weller[4, 5] correlates the Bethel sandstone with the Yankeetown chert of Mississippi Valley, which overlies the Renault formation, and Ulrich correlates it with the Aux Vases sandstone of Mississippi Valley, which underlies the Renault formation. The present writer does not feel that he is in possession of all the ascertainable data bearing upon the question of correlation, so does not attempt to express an opinion on the subject. There seems to be no question as to the identification of the Cypress sandstone from Illinois eastward into Kentucky and southward across Tennessee probably into northern Alabama, where it is believed to be the same as the Hartselle sandstone.[6]

GOLCONDA FORMATION

Name and distribution.—The Golconda formation was named from Golconda, Pope County, Illinois. The formation outcrops only in the fault blocks at the north end of Cave Hill and in the area of undivided Chester formations along the north slope of Wildcat Hills. A good exposure, with a dismembered head of its guide fossil, *Pterotocrinus capitalis,* was found in a ravine in the east end of the ridge about one-third of a mile west of Horseshoe Gap. Its outcrop in the fault blocks is characterized by strike ravines at the ends of the ridges.

Character.—The Golconda formation is essentially a succession of limestones and shales, but the outcrops are so generally talus covered that the details of the successive beds are obscured.

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[4] Weller, Stuart, Mississippian Brachiopoda of the Mississippi Valley basin: Ill. State Geol. Survey Mon. 1, p. 25, 1914.

[5] Weller, Stuart, and others, Geology of Hardin County: Ill. State Geol. Survey Bull. 41, p. 159, 1920.

[6] From recent work in Alabama it is concluded that the Hartselle sandstone is to be correlated with the Hardinsburg sandstone instead of with the Cypress sandstone. (This applies also to the discussion on page 28.)

The individual beds of limestone in the formation vary somewhat in character, but in the main they are gray or bluish in color, and more or less crystalline. Some minor beds are dense and compact in texture. The limestone beds in the lower portion of the formation are a mass of fossil fragments which weather with a rough surface, and in the weathered outcrops, at least, are likely to be stained a rusty brown color, either more or less uniformly or in irregular streaks.

The shales of the Golconda formation are fully as variable in character as the limestones. Some beds are almost wholly argillaceous, and gray, bluish, or essentially black in color. Other beds are calcareous, and gradations may be observed from the moderately calcareous shales to thinly bedded limestones with a considerable content of argillaceous material. In the lower portion of the formation some of the shale beds are more or less sandy, and they pass locally into sandstone beds of minor importance.

Thickness.—According to the best determinations the Golconda is 140 to 150 feet thick in Hardin and Pope counties, and it seems to be of equal thickness in this area.

Fossils.—The Golconda is highly fossiliferous, Weller listing 36 species, all common Chester forms, from a single collection from the southeastern part of Hardin County. In the area under description only the guide fossil *Pterotocrinus capitalis* was identified, this serving excellently to identify the formation and check the sequence of the steeply dipping and poorly exposed formations in the fault blocks near Horseshoe Gap.

Correlation.—Weller makes the statement[6]: "A comparison of the fauna of the Golconda formation with the Chester faunas that have been studied from the Mississippian valley counties in Illinois, establishes a very close relationship between the Golconda and the lower portion of the Okaw limestone."

Eastward the Golconda can be traced to central Kentucky, and is now known to be represented by a thin persistent shale extending from near Ohio River southward along the west escarpment of the Cumberland Plateau into northern Alabama. The guide fossil, *Pterotocrinus capitalis,* has recently been found by the writer at this horizon at the north end of Lookout Mountain at Chattanooga, Tennessee.

HARDINSBURG SANDSTONE

Name and distribution.—The Hardinsburg sandstone was named by Butts,[7] from Hardinsburg, the county seat of Breckinridge County, central Kentucky. In this area the Hardinsburg sandstone outcrops only in the fault blocks at the north end of Cave Hill, southwest of Equality. It is

[6] Weller, Stuart, and others, Geology of Hardin County: Ill. State Geol. Survey Bull. 41, p. 186, 1920.

[7] Butts, Chas., Descriptions and correlations of the Mississippian formations of western Kentucky: Kentucky Geol. Survey, p. 96, 1918.

nowhere well exposed, and the following description is based upon exposures south of Eagle Valley.

Character.—All along its outcrop south of Eagle Valley the Hardinsburg is a moderately fine-grained, gray, rather evenly thin-bedded to laminated sandstone. Locally, at least, there are minor beds of shale. On Pinhook Creek west of Karbers Ridge the formation includes a considerable thickness of evenly bedded, smooth-surfaced flagstones that have been quarried on a small scale in the NW. 1/4 sec. 7, T. 11 S., R. 8 E. In general the formation is less massive than the underlying Cypress sandstone, but locally there is little difference in this respect between the two formations.

Thickness.—Immediately south of Eagle Valley the Hardinsburg ranges in thickness from 30 feet to more than 50 feet, and presumably it is about that thickness in this area.

Fossils.—No fossils have been found in the Hardinsburg of this area. Weller, however, reports a few plant remains in the sandstone in Pope County. These have not been identified.

Correlation.—In Monroe County, Illinois, between the lower part of the Okaw formation (the part corresponding to the Golconda formation, underlying the Hardinsburg sandstone) and the upper part of the Okaw (the part corresponding to the Glen Dean, overlying the Hardinsburg) there is locally developed a thin sandstone which probably represents the Hardinsburg, which, like the Cypress, thins out westward. Eastward the Hardinsburg can be traced to its type locality in Breckinridge County, Kentucky, and it is represented by thin sandstone locally developed along the Cumberland escarpment southward into northern Alabama.

GLEN DEAN LIMESTONE

Name and distribution.—The Glen Dean limestone was so named by Butts,[8] from the town of Glen Dean, Breckinridge County, Kentucky. Like the other Chester formations the Glen Dean limestone outcrops in this area only in the fault blocks at the north end of Cave Hill and in the area of undivided Chester formations in the north slope of the Wildcat Hills.

Character.—The Glen Dean consists of limestones interbedded with shales. In general the limestone is crystalline and dark gray, but it includes layers of compact and very dark, brittle rock, breaking with a splintery fracture. Surficial redness developed by weathering is a common and widespread characteristic peculiar to the Glen Dean among Chester formations. Good examples of such rock, with characteristic fossils, were observed in sec. 3, T. 10 S., R. 7 E. The crystalline character is due to abundance of fossil fragments, especially crinoidal plates. On extreme weathering such

[8] Idem, p. 97.

rock becomes crumbly and shaly. Some of the rock is apparently very pure, while some is highly siliceous. There is some chert, which commonly occurs in plate-like layers one or two inches thick, most or all of which are colored dark chocolate-brown on freshly broken surfaces. In some localities the presence of these chert fragments in the residuum is the only evidence of the existence of the limestone. Another feature of the Glen Dean limestone that is worthy of mention is a somewhat widely distributed oolitic limestone bed in the upper part of the formation. Between some of the denser limestone layers there are thin shale partings, some of which beds are argillaceous, breaking down into a plastic clay; others calcareous, and others siliceous.

Thickness.—The best estimates of thickness that can be made range from 50 to 70 feet, and about 60 feet may be considered a fair average.

Fossils.—The Glen Dean is a highly fossiliferous formation, from which about 50 species have been collected and identified by Weller[9] from Hardin and Pope counties. Most of them are common Chester forms, but a few are either confined to the Glen Dean or are more common in it than in others. Among such species the most significant is the bryozoan *Prismopora serrulata,* which may be found in practically every Glen Dean fauna, and in some localities it is a very common form. The species is not wholly limited, however, to the Glen Dean formation, for it has been collected in the earlier Golconda formation and in the later Vienna limestone, and even in the Menard. In the Golconda it is very rare, and has been observed in but a single locality, and was there represented by a single specimen. As contrasted with its occurrence in these older and younger faunas, the species is conspicuous in the Glen Dean, being found in practically every outcrop of any size, and it is the first fossil to be sought for when the recognition of the Glen Dean formation is involved. It was found in the red limestone in sec. 3, T. 10 S., R. 7 E. Another fossil, which so far as known has not been collected outside of the Glen Dean, is the large *Pentremites spicatus,* which is much more local in its occurrence than the *Prismopora,* and has been observed in but few of the Hardin County collections, although it has been found more commonly in Pope County and at Carrsville, Kentucky. Another bryozoan which has been found to be quite characteristic of the Glen Dean horizon in Kentucky and elsewhere, but which has not yet been observed in southeastern Illinois, is *Archimedes laxus.* The peculiar "wing plates" of *Pterotocrinus bifurcatus* is another form in the same category. Any one or all of these species may be sought for in the

[9] Weller, Stuart, and others, Geology of Hardin County: Ill. State Geol. Survey Bull. 41, p. 195, 1920.

Glen Dean of this region. *Pentremites brevis* and *P. canalis* are also found only in the Glen Dean limestone.

Correlation.—Weller says:

"A comparison of the fauna of the Glen Dean formation with the faunas of the Chester group in Randolph County, shows a close similarity between this fauna and that of the upper division of the Okaw limestone in the more western section. In both faunas the bryozoan *Prismopora serrulata* is a characteristic form; in the more western region the species has not been met with at any other horizon than the upper Okaw, and in the southeastern part of the State it has been met with only rarely in any other horizon than the Glen Dean. In both regions the large *Pentremites spicatus* is known only at this horizon. A number of other characteristic Glen Dean species, such as *Archimides laxus*, and *Pterotocrinus bifurcatus*, which have not been collected in Hardin County but which are known in Kentucky, are also present in the upper Okaw of Randolph County. With so many features in common between the Glen Dean and the upper Okaw faunas the correlation of the two formations may be considered as established, especially as they occupy corresponding positions in the stratigraphic series of the two regions."

The entire assemblage of fossil species so characteristic of the upper Okaw (Glen Dean) horizon occurs at Sloans Valley, Pulaski County, in southeastern Kentucky, from which locality a number of the characteristic species were first described and there can be no question of the presence of equivalent strata in the Chester section at that locality. The Glen Dean also is represented by nearly the upper half of the Newman limestone of southwest Virginia and the lower few hundred feet of the Bangor limestone of Alabama, being thus one of the most geographically extensive of the Chester units.

TAR SPRINGS SANDSTONE

Name and distribution.—The Tar Springs sandstone was named by Owen[10] from the tar springs 3 miles south of Cloveport, Breckinridge County, Kentucky. The Tar Springs sandstone is present in beds fairly thick in the fault blocks southwest of Equality.

Character.—Like the Hardinsburg and Cypress sandstones, the Tar Springs is a yellowish-brown sandstone, becoming distinctly reddish in places. It contains also some very white layers, which, however, are likely to be stained brown on the outside, by the surficial oxidation of the small amount of iron present. On the whole the color is more like that of the Hardinsburg, being distinctly less pale than much of the Cypress. In texture the sandstone is moderately fine grained, not essentially different from the other two formations that have been mentioned.

The basal portion of the Tar Springs sandstone consists of massive beds, which locally are remarkably cross-bedded. Cross-bedding is con-

[10] Owen, D. D., Geol. Survey of Kentucky, Vol. 1, p. 174 and Vol. 2, pp. 86-87, 1857.

spicuous throughout the formation, as are ripple-marked surfaces and other surfaces with markings indicating shallow-water conditions. The upper portion of the formation is notably more thinly and more evenly bedded than the lower part, although locally as thickly bedded.

In the midst of the Tar Springs sandstone there is, locally at least and perhaps generally throughout southern Illinois, a shaly member 40 feet or less thick, in which is a thin bed of impure coal. The bed is composed of dark to black, more or less carbonaceous shale, and thinly laminated to shaly, fine-grained, gray sandstone, coated black on the surfaces of the laminae by carbonaceous matter. Poorly preserved fossil plants, mainly undeterminable stems, occur here and there in this shale, and at Stone Church, 2 miles west of Elizabethtown, are well-preserved fossil plants in shale probably in the Tar Springs.

Thickness.—In none of the exposures in this area is the Tar Springs sandstone sufficiently well exposed to furnish a basis for a satisfactory determination of its thickness. From the exposures in Pope County, however, where the thickness can be estimated with some degree of accuracy, it seems to vary from 100 to 150 feet. About the same thickness may be assumed for this area. The Tar Springs is the thickest of the several Chester sandstone formations in the area.

Fossils.—The only fossils that have been observed in the Tar Springs formation in the area covered by this report and in adjoining parts of Hardin County, are plant remains. These have been identified by David White as follows:

Cardiopteris polymorpha Göpp   Lepidodendron sp. undet.
Sphenopteris sp. undet.

The excellent condition of preservation of these fossil plants, which of course lived upon land, shows that they could have been transported no great distance, and consequently that the land where they grew must have been near.

Correlation.—In Breckinridge County, Kentucky, the same species of *Cardiopteris* that has been identified in Hardin County is known from the typical Tar Springs, and associated with it is a *Lepidodendron* comparable with the one recorded from Stone Church. Such evidence helps to corroborate the correlation of this sandstone formation in the two regions. *Cardiopteris polymorpha* is also known from beds regarded as of middle Chester age at Abbs Valley, Virginia, and it is found in the Mississippian of Europe.

In the Randolph County, Illinois, section of the Chester group the upper Okaw limestone, which is the equivalent of the Glen Dean limestone of this region, is overlain by the Menard limestone. In southeastern Illinois and in Kentucky these two limestones are separated by the thick Tar Springs sandstone. In the Randolph County section, therefore, the position of the Tar Springs sandstone is between the Okaw and Menard limestones, but the sandstone is absent. A comparison of the western extension of the Tar Springs with that of the earlier Hardinsburg, Cypress, and Bethel sandstones, shows that all are similar in regard to their thinning to the west, but that although all three of the earlier formations have at least some representation in Randolph County, the Tar Springs sandstone has thinned out entirely and disappeared.

VIENNA AND MENARD LIMESTONES

Names.—The Menard limestone was named by Weller, from Menard, near Chester, Illinois, where the formation is overlain by the Palestine sandstone. In Hardin County, where a detailed survey was next made, limestone of Menard character, with subordinate amounts of shale, occupies the interval below the Palestine sandstone down to the Tar Springs sandstone. These rocks were at first supposed to correspond to the Menard. With the progress of the Survey westward through Pope, Johnson, and Union counties, however, a thick sandstone was discovered in the lower part of this supposed Menard. This made it necessary to treat the part below the newly discovered sandstone down to the Tar Springs sandstone as a distinct formation, which Weller named the Vienna limestone, from Vienna, Johnson County, while the new sandstone was named the Waltersburg, from a small village in Pope County. Further work led to the conviction that only the limestone between the Waltersburg and Palestine sandstones corresponds to the typical Menard, and therefore Weller stated[11] that the rocks mapped as Menard limestone in that county probably included the Vienna limestone, and that notwithstanding the absence of the Waltersburg sandstone the two limestones could probably be separated when further detailed work is done. Owing, however, to the fact that the Waltersburg sandstone is not present in the area here described, or is so inconspicuous as not to be observable, the Vienna and Menard limestones are not easily separable, and are herein mapped and described together.

Distribution.—The Vienna and Menard limestones outcrop in the fault blocks southwest of Equality, and the Menard also outcrops on the axis of the Horton Hill anticline, in secs. 32 and 33, T. 10 S., R. 7 E.

Character.—The nearest point to the area under description at which the Vienna limestone is certainly identifiable, namely, where the Waltersburg sandstone is present, in sec. 33, T. 11 S., R. 7 E. and secs. 4 and 5, T. 12 S., R. 7 E., 8 miles due south of Horton Hill, the Vienna appears to be composed mainly of dark shale with layers of ferruginous, rusty weather-

[11] Weller, Stuart and others, Geology of Hardin County: Ill. State Geol. Survey Bull. 41, p. 202, 1920.

ing limestone. Beds of this character immediately overlie the Tar Springs sandstone throughout Hardin and Pope counties, and undoubtedly represent the Vienna limestone. Locally the limestone is cherty, as at Vienna, and locally there is a thin coal bed about 10 feet above the Tar Springs sandstone.

The Menard formation is composed of shale and limestone, the limestone predominating. The limestone layers are commonly deposited in beds a foot or more in thickness, which are separated by shaly partings. The limestone is mostly a dense, fine-grained, compact rock, bluish, dark gray, or nearly black in color. The weathered surfaces of the outcrops are smooth, and are commonly lighter in color than the freshly broken surfaces, in most places being light gray or bluish. In its lithologic characters the Menard limestone is in rather strong contrast with the Glen Dean and Golconda formations, its smoothly weathering surfaces and dense, compact texture being very different from the rough or crumbly weathered surfaces and the granular or crystalline texture of the two older formations.

Thickness.—The thickness of the Vienna and Menard limestones cannot be directly measured with certainty in this area owing to conditions of outcrop, but the best estimates indicate a thickness of approximately 80 to 165 feet.

Fossils.—Weller has identified 47 species of fossils from the Vienna and Menard of Pope County, mostly common Chester species. Those more characteristic of the Menard are described by Weller as follows:

"A single species of *Pentremites* is recorded, *P. fohsi*, a large form but not so large as *P. obesus* from the basal Golconda. This species has been met with wherever any considerable collection from this zone has been made in southern Illinois from Union to Hardin counties, and it has not been collected from any other horizon. Among the crinoids a species of *Pterotocrinus*, represented only by the 'wing plates', has been found to be very characteristic. The members of this highly specialized genus have proved to be excellent horizon markers in the Chester group, the small spatulate plates with serrate border in the Paint Creek, the massive, subglobose plates of *P. capitalis* in the Golconda, the peculiar bifid plates of *P. bifurcatus* in the Glen Dean, and now again in the Menard these very large, flattened, subcircular plates of a new species, *P. menardensis*, which is allied to *P. spatulatus*. The detached, spinose, summit plates of a species of *Hydreioncrinus* have been collected in abundance from this horizon at a number of localities, being met with much more commonly at this horizon than anywhere else in the Chester series of southeastern Illinois. Likewise the plates and spines of the echinoid genus *Archaeocidaris* are more commonly met with in this portion of the Menard than at any other Chester horizon in the region. The bryozoans are represented by the same genera and mostly by the same species that are present in other Chester faunas. Among the brachiopods most of the species are commonly present in other Chester horizons, but the typical *Spirifer increbescens*, larger and coarser in appearance than the representatives of the same species in earlier faunas, is abundant, and the smaller *Composita trinuclea* is displaced by the larger and broader *C. subquadrata*. The form of *Eumetria* that is commonly met with in this horizon is the *E. costata*, a larger and coarser form than the *E. vara* which was the usual member of the genus in the older faunas. The presence of the pelecypod *Sulcatopinna missouriensis* is a very characteristic mark of the Menard formation."

Correlation.—According to Weller:

"The character of the series of sediments occupying the interval between the Tar Springs and the Palestine sandstones in Hardin County, closely resembles the series of beds occupying the interval between the Okaw limestone and the Palestine sandstone in Randolph County. The upper, main body of limestone, as developed in this area is clearly continuous westward, and is undoubtedly the exact equivalent of the typical Menard limestone in the Mississippi river section. While no such prolific fauna, with *Pentremites fohsi*, such as has been recorded from Pope County, has been observed in Randolph County, the general fauna of the formation, with *Sulcatopinna missouriensis*, the large *Composita subquadrata* and *Spirifer increbescens*, is present throughout. The lithologic character of these beds, also, is remarkably similar throughout the whole extent of the formation, the only noticeable difference between the limestones of this area and those of Randolph County being the somewhat darker color of the rock from the southeastern part of the State. When all the data are considered there seems to be no question as to the exact correlation of these beds entirely across the State."

PALESTINE SANDSTONE

Name and distribution.—The Palestine sandstone was named by Weller[12] from Palestine Township, Randolph County, Illinois. Palestine sandstone was found on the crest of the Horton Hill anticline on Gibbons Creek, in secs. 32 and 33, T. 10 S., R. 7 E. The sandstone is present too in the fault blocks at the north end of Cave Hill, southeast of Equality, and is probably present, though not actually identified, in the area along the north side of the Wildcat Hills in which the various units of the Chester group could not be distinguished with certainty.

Character.—In its general composition the Palestine sandstone is more thinly bedded than the lower Chester sandstone formations, although locally it does contain rather thick-bedded layers. Some layers are distinctly shaly, but the shales are arenaceous in character, being quite unlike the clay shales which are associated with some of the older sandstones. Some of the surfaces are ripple-marked, and some layers exhibit distinct cross-bedding. The rock is fine grained in texture and yellowish brown in color, much of it being of a paler tint than most of the Tar Springs and Hardinsburg sandstones.

Thickness.—The Palestine is one of the thinner sandstone formations of the Chester group in southeastern Illinois, having an approximate thickness of 60 feet, although in northwestern Hardin County the thickness appears to be fully 100 feet.

[12] Weller, Stuart, Mississippian Brachiopoda of the Mississippi valley basin: Ill. State Geol. Survey Mon. 1, p. 29, 1914.

Fossils.—The only fossils which have been met with in the Palestine are more or less fragmentary tree trunks of the genus *Lepidodendron*, which has been identified by David White as *L*. cf. *modulatum*.

Correlation.—The Palestine is the first of the Chester sandstone formations that is equally well developed in the southeastern Illinois section and in the Randolph County section. In both regions the sandstone occupies the same position in the section, and it maintains approximately the same thickness throughout. There can be no question as to the continuity of the bed throughout the entire Illinois basin of Chester time.

CLORE AND KINKAID LIMESTONES

Names.—The rocks described under this heading include possibly three units, which in Pope and Johnson counties to the west and southwest of the area covered by this report, can be readily separated by virtue of the fact that the intervening Degonia sandstone is there persistently thick enough to be recognizable. These units were named by Weller[13] Clore limestone, Degonia sandstone, and Kinkaid limestone, in ascending order. The field work in the parts of these quadrangles situated in Hardin County having been done before that on the areas farther west, and no sandstone corresponding to the Degonia being recognized, the entire thickness of rocks between the Palestine sandstone and the bottom of the Pottsville sandstone was treated as a single unit in the report on Hardin County[14] and in this report.

Distribution.—The Clore and Kinkaid limestones outcrop around the outside of the oval area 1½ miles northwest of Herod. There are smaller areas still farther west in sec. 31, T. 10 S., R. 7 E., in the fault blocks at the north end of Cave Hill, and probably along the north slope of the Wildcat Hills. Partial exposures of the Clore and Kinkaid are common in the fault blocks, and there is an especially good one along the road leading up to Cave Hill in the NW. ¼ sec. 3, T. 10 S., R. 7 E., about 6 miles southwest of Equality.

Character.—The Clore and Kinkaid rocks consist of limestone, shale, and sandstone, the limestone being the greatest and the sandstone the least constituent.

An exposure of the whole unit in and near the road at the west base of the north end of Cave Hill, in the NW. ¼ sec. 3, T. 10 S., R. 7 E., reveals its character in that locality, and probably for all its outcrops

[13] Weller, Stuart, Chester series in Illinois: Journal of Geology, Vol. 28, No. 5, p. 402, 1920.

[14] Weller, Stuart, and others, Geology of Hardin County: Ill. State Geol. Survey Bull. 41, p. 212, 1920.

north of Cave Hill and Wildcat Hills. A section at the place described is given below:

Outcrop of Kinkaid and Clore limestones in the NW. ¼ sec. 3, T. 10 S., R. 7 E.

	Thickness *Feet*
Pottsville (?) group	...
Kinkaid and Clore limestones:	
13. Shale	30
12. Limestone, gray, evenly bedded in layers about 1 foot thick	60
11. Shale, red	5
10. Limestone	5±
9. Shale	10
8. Limestone	20
7. Shale	40
6. Limestone, blue, pure?	20±
5. Shale, green	5
4. Shale, red	5
3. Not exposed	10
2. Limestone	20±
1. Shale	40±
Total	270
Palestine sandstone	...

The absence of sandstone from this section is worthy of note. The separation of the mass into two formations, the Clore and Kinkaid, seems impracticable.

Thickness.—As shown by the section, the thickness of the Clore and Kinkaid limestones in this area is 270 feet.

Fossils.—All the limestone beds in the Clore part of the unit contain more or less fragmentary fossils, most of which are too imperfect to be determined. In some of the shaly beds are better fossils, of which about 40 species have been collected and identified by Weller, who remarks as follows:

"The presence of the large and broad *Composita subquadrata* and of the large *Spirifer increbescens* marks this fauna as of upper Chester age, that is, it could not be older than the Menard. Most of the other species might be present in any one of several other Chester horizons, although the rather large *Productus* that has been referred with a query to *P. arkansanus* has not been observed elsewhere. The one species that is most significant is the bryozoan *Batostomella nitidula*. This little branching cylindrical form occurs rather commonly upon the surfaces of the limestone layers in the lower portion of the Clore, and has not been collected by the writer from any other horizon in southern Illinois. It is perhaps the best index fossil for this horizon."

Most of the limestone beds in the Kinkaid part of the unit are more or less fossiliferous, but the fossils are not generally preserved in such a manner as to be properly identified. The shale beds are commonly very little if at all calcareous, and are likely to be barren of fossils, this being especially true of the red and olive-green shales. From one layer in the limestone in the NE. 1/4 SW. 1/4 sec. 30, T. 12 S., R. 8 E., two miles northwest of Rosiclare, seventeen species have been identified, of which Weller states[15]:

"This fauna has nothing strikingly distinctive about it, and were not its horizon definitely fixed by its stratigraphic relations it might be considered as of middle Chester age. The examples of *Composita* which are present are the *C. trinuclea* type, identical with those which occur commonly in the middle and lower Chester faunas, and not at all like the large and broad examples of *C. subquadrata* of the Menard and Clore. The examples of *Martinia contracta* most resemble those which have been collected from some of the higher beds of the Glen Dean formation near Golconda, in Pope County.

"A collection from the outcrops of Kinkaid limestone on Kinkaid Creek in Jackson County, exhibits the same features as those just recorded from Hardin County. A species of Martinia, apparently the same as that in the list just given, is one of the common forms, and the *Composita* present is of the *C. trinuclea* type rather than the large form so common in the Menard and Clore limestones. A number of pelecypods are present in the fauna, among them the Menard species *Sulcatopinna missouriensis*."

UNCONFORMITY BETWEEN MISSISSIPPIAN AND PENNSYLVANIAN ROCKS

The uppermost Mississippian formation in southern Illinois is overlain by the Caseyville sandstone, the lowest formation of the Pennsylvanian series. The Clore and Kinkaid are probably not the youngest formations laid down in Mississippian time, and the Caseyville certainly is not the oldest formation of Pennsylvanian time. Between the time represented by the top of the Kinkaid and the time of deposition of the basal beds of the Caseyville in Illinois there was formed, along the eastern margin of the Appalachian coal fields, a great series of rocks that is not represented in Illinois, but which, if present, would lie between the Kinkaid and the Caseyville. These beds which are lacking from the Illinois section constitute the lower part of the coal-bearing rocks of the anthracite fields of eastern Pennsylvania, the rocks of the Pocahontas coal field of Virginia and West Virginia, and the "Coal Measures" of Alabama, the aggregate maximum thickness of which is probably not less than 12,000 feet. These lowest "Coal Measures" rocks which are not represented in the Illinois section are classed as lower and middle Pottsville. The oldest Pottsville rocks of Illinois are of middle and upper Pottsville age, and correspond in the time of their origin with the beds which overlie the lower Pottsville and the lower part of the middle Pottsville rocks of the Appalachian coal fields. The stratigraphic relations of these formations are shown by the accompanying diagram, figure 2.

[15] Idem, p. 222.

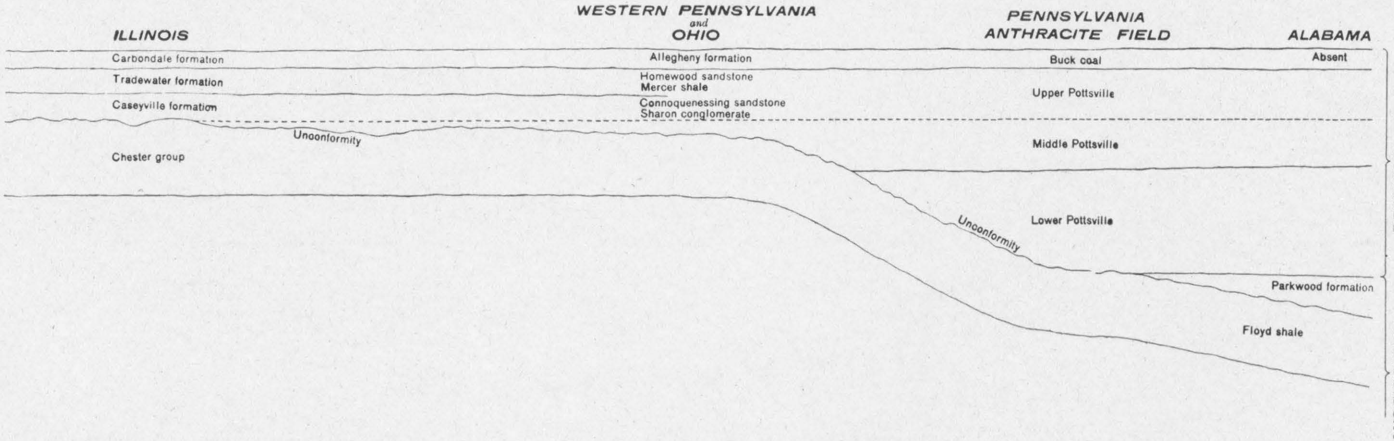

Fig. 2. Diagram showing the relations of the Mississippian and Pennsylvanian systems in the eastern part of the Appalachian coal field, and in Illinois. The absence of the Parkwood formation, lower Pottsville, and middle Pottsville from Illinois is shown, and the resulting unconformity is represented by the uneven line.

PENNSYLVANIAN SYSTEM

GENERAL DESCRIPTION

The Pennsylvanian system, commonly called the "Coal Measures" by earlier geologists, takes its name from the state of Pennsylvania, where the coal-bearing rocks are typically developed, and where they first became well known in America through coal-mining operations. The most distinctive feature of the Pennsylvanian system in eastern North America is its coal beds. In the Equality and Shawneetown quadrangles in Illinois the Pennsylvanian system is divided into four formations, named, in ascending order, the Caseyville, Tradewater, Carbondale, and McLeansboro formations. The Caseyville and Tradewater formations belong to the Pottsville series, named from Pottsville, a city in the anthracite coal field of eastern Pennsylvania, where the rocks are typically developed.

CASEYVILLE SANDSTONE

Name and distribution.—The Caseyville formation was named by Glenn,[16] from Caseyville, Kentucky, in the Shawneetown quadrangle. The Caseyville sandstone outcrops in two bands, extending east and west across the middle part of the area, which converge and meet at the southwest end of Eagle Valley. The formation makes high bluffs along the southern belt of outcrop, marked by such high points as High Knob, Buzzards Point, and Horton Hill. The northern belt marks the top of Cave Hill, Wildcat Hills, and Gold Hill. These two belts are connected beneath the valley of Eagle Creek and the central area of the quadrangles extending to Ohio River, by a continuous sheet of the formation. There are good exposures of the formation along the river in Battery Rock Township, T. 11 S., R. 10 E., along Blind Hollow in the same township just south of the mouth of Saline River, and along the high bluff north of Karbers Ridge in sec. 9, T. 11 S., R. 8 E. The basal conglomerate of the formation makes the conspicuous cliff at the top of Cave Hill. Part of the formation is exposed at Shawneetown at low water stages of Ohio River. There are many fine cliff exposures in the ravine heading in the ridge south of Eagle Creek.

Character.—The Caseyville is composed of sandstone, conglomerate, and shale, as shown in the generalized columnar section (Pl. I). At the bottom of the formation in Battery Rock and Rock Creek townships, south of Saline River there is a sandstone 40 feet thick, locally containing conglomeratic layers with rather abundant small quartz pebbles. This sandstone yields some large masses, 20 feet or more in thickness, along the base of the river bluff in sec. 2, T. 12 S., R. 10 E. It also forms the low

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[16] Glenn, L. C., Coals of the Tradewater region, Kentucky Geol. Survey Bull. 17, 1912.

basal cliff high up on the points of the spurs or near the brows of the hillsides northeast of Honey Creek valley between Lamb and Zion Church, where it rests upon the Menard limestone, of the Mississippian. Elsewhere in the region this bed seems to be wanting from the Caseyville section. Overlying this basal sandstone member, or resting upon the Chester limestone where the sandstone is not present, there are about 100 feet of interbedded sandstone and shale overlain by a second sandstone and conglomerate member 60 feet thick. This member is thick-bedded and mostly coarse and friable in texture, with quartz pebbles up to one-half inch in diameter scattered about locally or in irregular nests and pockets. It is the massive cliff-making sandstone at Battery Rock Landing, and is the basal sandstone along the southern border of this area and in Cave Hill and the Wildcat and Gold hills to the east as far as Shawneetown. Above the second sandstone and conglomerate member is about 100 feet of thin sandstone and shale including, near the top, the Battery Rock coal bed or its horizon. The coal is known only on the knob near and slightly north of west of Battery Rock, south of the area herein described. Overlying the second mass of shale and sandstone is the third conglomerate and sandstone member of the Caseyville, over 100 feet thick, forming the top of the formation. This uppermost member is similar in lithologic character to the two lower sandstone and conglomerate members. It forms the high cliffs near Sellers Landing, and also those at the mouth of Cane Creek and along Blind Hollow, south of the mouth of Saline River. The same bed forms the high cliffs at the Pounds, in sec. 36, and continues westward along the county line, where it caps High Knob in sec. 33, and forms the cliff at Buzzards Point in sec. 32, all in T. 10 S., R. 8 E.

Coal in the Caseyville, probably at the horizon of the Battery Rock coal, was observed at two places southwest of the southwest end of Eagle Valley and outside of the area covered by this report, but no coal of importance has been discovered in the Caseyville of this area.

Thickness.—The entire thickness of the Caseyville is probably about 400 feet, divided between the various members, as stated in the foregoing description. Because the full thickness of the formation is not present and accessible at any one locality, it is impossible to make a direct measurement of it, and the thickness as given had to be compiled from measurements made of different members at different points, with a consequent possibility of considerable error.

Fossils.—A good collection of fossil ferns has been obtained from the Caseyville formation on the west side of Stone Hill, Hardin County, in the SW. ¼ sec. 17, T. 12 S., R. 8 E., south of this area. The plants occur in a dark, sandy shale that apparently underlies the middle conglomerate of the complete Caseyville section. At this place the lowest conglomerate is believed to be absent, and the plant-bearing shale is not a great distance above the top of the Kinkaid limestone of the Chester group. The species of the ferns, as identified by David White, are listed below:

Fossil ferns from the Caseyville sandstone collected on Stone Hill, in the SW. ¼ sec. 17, T. 12 S., R. 8 E.

Alethopteris decurrens (Artis)	Cheilanthites cf. macilenta
Alethopteris grandifolia Newb.	Megalopteris sp.?
Alethopteris lonchitica (Schl.) (Ohio form)	Neuropteris cf. N. obliqua
	Sphenopteris communis Lesq.
Cardiocarpon sp.?	Whittleseya microphylla Lesq.

Correlation.—According to White the species of ferns recorded in the foregoing list indicate a horizon probably near that of the Sharon conglomerate, the basal member of the upper Pottsville of western Pennsylvania. It is possible, however, that the flora may fall in the upper part of the middle Pottsville. The beds containing this flora are probably of Morrow age. The oldest known floras from the Pottsville in Illinois are of middle Pottsville age, with a possibility that the lowest flora, as yet but little seen, may be of lower Pottsville age. The lowest plant horizon noted on Battery Rock is of middle Pottsville age. The Caseyville includes beds older than the lowest of the "Coal Measures" of Missouri, which probably correspond more closely to the overlying Tradewater formation.

TRADEWATER FORMATION

Name.—The Tradewater formation was named by Glenn,[17] from Tradewater River in Kentucky, east of Caseyville, along which stream it has a good width of outcrop. It includes all the beds between the top of the upper conglomerate of the Caseyville and the Davis coal, which is the equivalent of the Murphysboro or No. 2 coal of Illinois.

Distribution.—The Tradewater formation outcrops in two main bands parallel to and within those occupied by the outcrop of the Caseyville sandstone on both sides of Eagle Valley, and there is also a large area of Tradewater in the southwest corner of the territory covered by this report.

Character.—The Tradewater formation is composed mainly of sandstone and shale, but it includes a bed of conglomerate or conglomeratic sandstone (herein named the Grindstaff sandstone member, thin limestones (one of which is known as the Curlew limestone), and several thin coal beds. The detailed lithologic character of the formation is shown by the following section, quoted from Lee.[18] The upper 103 feet of the section is from a drill hole near Sturgis, Kentucky, and the next 433 feet below to the Bell

[17] Glenn, L. C., Coal of Tradewater River region: Ky. Geol. Survey Bull. 17, 1912.

[18] Lee, Wallace, Geology of the Shawneetown quadrangle in Kentucky: Ky. Geol. Survey, p. 20, 1916.

coal bed from a hole midway between Sturgis and Caseyville, Kentucky. The part of the section below the Bell coal is compiled from surface observations near Caseyville.

Section of Tradewater formation

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Gray shale	22	..	22	..
Gray slate	10	..	32	..
Black slate	11	..	43	..
Coal	..	6	43	6
Gray shale	11	..	54	6
Limestone	2	..	56	6
Black slate	2	..	58	6
Coal	..	4	58	10
Gray shale	13	..	71	10
Yellow shale	4	..	75	10
Gray shale	11	..	86	10
Sandstone ("Curlew" sandstone of Owen)	6	..	92	10
Black slate	4	..	96	10
Coal	..	3	97	1
Fire-clay	1	..	98	1
Sandstone	5	3	103	4
Dark slate	2	..	105	4
Fire-clay	1	..	106	4
Shale, mixed with fire clay	7	..	113	4
Dark shale [horizon of Curlew limestone (?) of Owen]	38	..	151	4
Dark sandy shale	6	4	157	8
Dark shale	14	..	171	8
Variegated shale	1	..	172	8
Dark sandy shale	5	..	177	8
Coal	0	10	178	6
Shale, mixed with soapstone	5	..	183	6
Dark shale	6	2	189	8
Sandstone	7	..	196	8
Shale, mixed with fire clay	2	..	198	8
Dark slate	2	..	200	8
Sandy shale	4	..	204	8
Dark, sandy slate	5	..	209	8
Sandstone and shale, mixed	22	..	231	8
Bastard fire clay	1	..	232	8
Coal	0	8	233	4
Shale, mixed with soapstone	4	..	237	4
Dark slate	15	..	252	4
Gray, sandy shale	16	..	268	4
Dark slate	6	4	274	8
Coal, Smith (?)	1	10	276	6
Coal and slate mixed	1	..	277	6
Shale, mixed with soapstone	5	..	282	6
Coal	0	5	282	11

Section of Tradewater formation—Concluded

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Sandstone	5	..	287	11
Gray shale	0	7	288	6
Dark shale mixed with soapstone	10	..	298	6
Sandy shale	5	..	303	6
Sandstone	38	6	342	..
Dark slate	1	6	343	6
Coal	1	2	344	8
Shale, mixed wth fire clay	9	10	354	6
Dark slate Coal (Ice House?)	2	..	356	6
Sandy slate	10	..	366	6
Coal and bony coal	1	6	368	..
Shale	1	..	369	..
Shale, mixed with fire clay	1	6	370	6
Sandstone (Finnie sandstone of Owen)	44	..	414	6
Sandy shale	4	..	418	6
Dark slate	9	..	427	6
Sandy shale	3	..	430	6
Sandstone	10	..	440	6
Dark slate	3	..	443	6
Shale, mixed with fire clay	4	..	447	6
Sandy shale	8	..	455	6
Dark blue, shaly slate	70	..	525	6
Coal (Bell)	3	6	529	..
Shale, mixed with fire clay	2	6	531	6
Shale, in part sandy	20	..	551	6
Clay shale, bluish	15	..	566	6
Clay shale, sandy, with iron stone	6	..	572	6
Clay shale, black, slaty	4	..	576	6
Coal, 1 A of Owen	..	8	577	2
Fire clay	1	..	578	2
Shale and sandy shale	16	..	594	2

In Illinois the lower part of the Tradewater is somewhat different from that part of the formation in Kentucky, as shown by the following section, which is compiled from observations in secs. 30 and 31, T. 10 S., R. 9 E:

Composite section of the Tradewater formation in secs. 30 and 31, T. 10 S., R. 9 E.

	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Tradewater formation:				
10 Sandstone	10	..	10	..
9 Shale	60	..	70	..
8 Sandstone	30	..	100	..
7 Coal, Willis (Bell?)	3	6	103	6
6 Clay	5	..	108	6
5 Sandstone, (Grindstaff sandstone member)	40	..	148	6

Composite section of the Tradewater formation in secs. 30 and 31, T. 10 S., R. 9 E.
—Concluded

	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Tradewater formation:—Concluded				
4 Shale	20	..	168	6
3 Coal (No. 1 A of Ky.)	..	8	169	2
2 Shale	10	..	179	2
Caseyville sandstone:				
1 Sandstone, thick-bedded, quartzitic, conglomeratic, exposed	20	..	199	2

On comparison this section is seen to differ from that in Kentucky by having a thick sandstone bed both below and above the Willis coal, which is probably the same as the Bell coal of Kentucky. Above the sandstone No. 10 of the preceding section, the Tradewater in Illinois is, so far as known, identical in general character with the corresponding part of the section in Kentucky.

The log of the bore hole in Kentucky shows eleven thin coal beds, and bore holes in Illinois show an equal number in the Tradewater of that region, distributed through the formation at about the same intervals as in Kentucky. With only one known exception, none of the coals is thick enough to mine. The exception is the Willis coal, which is 3½ feet thick at the Willis mines, in SE. ¼ SW. ¼ sec. 30, T. 10 S., R. 9 E., but it does not appear to hold that thickness over any considerable area. It is believed to be the same as the Bell coal of Kentucky but owing to a measure of uncertainty on that point it is named from the property where it is mined.

Grindstaff sandstone member.—The Grindstaff sandstone is here named from Grindstaff Hollow, in which, in the northeast corner of sec. 28, T. 10 S., R. 8 E., the sandstone is prominently displayed. It is persistent completely around the sandstone rim of Eagle Valley, in the Equality quadrangle, but was not identified in the Gold Hills, in the Shawneetown quadrangle, nor far beyond a point 1½ miles eastward into that quadrangle on its outcrop south of Eagle Valley. The member is 40 to 60 feet thick.

This member is distinguished by its coarse gray, quartzose, and conglomerate character, in which it resembles the conglomerate members of the underlying Caseyville sandstone. It is however, as clearly shown in the Illinois section, 30 to 40 feet above the top of the Caseyville.

Curlew limestone member.—In the western part of the Equality quadrangle there is a limestone in the upper part of the Tradewater formation that is correlated with the Curlew limestone of Kentucky, named by Owen. The exact position of this limestone in the Tradewater is about 100 feet below the top. In one bore hole the distance is 94 feet and in another, 4 miles away, it is 106 feet below the Murphysboro coal which represents the base of the Carbondale formation.

The member is best displayed around the head and west side of Eagle Valley and on the west side of Cave Hill in the vicinity of Somerset. There are excellent exposures of it in the SW. ¼ sec. 2, T. 10 S., R. 7 E., on the brow of the spur just west of the road in the NE. ¼ sec. 15, T. 10 S., R. 7 E., and on the low ridge just south of the valley in the northeast part of sec. 27, T. 10 S., R. 7 E. It is also well displayed at Somerset and along the road to the north for one-fourth mile, and thence eastward along the road between secs. 8 and 17, T. 10 S., R. 7 E.

The rock is a thick-bedded gray limestone. This character is shown at only a few places, however. As a general rule the member is displayed only as a profusion of chert scattered on the surface above the outcrop of the limestone. The limestone is highly fossiliferous, Brachiopoda and Bryozoa being the principal forms. The thickness probably does not exceed 20 and may not exceed 10 feet.

Thickness.—The total thickness of the Tradewater formation is approximately 600 feet.

Fossils.—No fossils, either plants or animals, have been obtained from the Tradewater except the marine invertebrates from the Curlew limestone member, a list of which follows.

List of fossils from the Curlew limestone member of the Tradewater formation

Lophophyllum profundum	Productus cora
Rhombopora	Productus semireticulatus
Cystodictya carbonaria	Marginifera muricata
Pinnatopora whitei	Dielasma bovidens
Fenestella modesta	Spirifer cameratus
Fenestella remota	Spirifer opimus
Polypora fastuosa	Spiriferina kentuckiensis
Prismopora sereata	Squamularia perplexa
Septopora biserialis	Composita subtilita
Derbya crassa	Orthoceras rushense
Chonetes mesolobus	

Some of the species of this list range through a large part of the Pennsylvanian system, and two, *Prismopora sereata* and *Productus semireticulatus,* do not appear to be distinguishable from species occurring in the Mississippian. *Chonetes mesolobus* and *Spirifer opimus* do not appear to range above the Allegheny formation, with which the Carbondale formation is correlated. *Spirifer opimus* has generally been identified as *Spirifer rockymontana.* A noteworthy feature of this fauna is the occurrence of Bryozoa, which are abundant and appear to be especially characteristic of a bed at the very top of the Pottsville in Jackson and Vinton counties, Ohio, marked by a black flint. Prismopora is rare in the Pennsylvanian, and the occurrence of an apparently identical species at the two localities may have considerable correlative value, so that the Curlew limestone member may reasonably be correlated with the black flint which immediately overlies the Homewood sandstone, the top member of the Pottsville formation in eastern Ohio and western Pennsylvania and immediately underlying the Brookville coal, the lowest bed of the Allegheny formation. It follows that it is possible that the Murphysboro coal, 100 feet or so above the Curlew limestone member, and taken as the base of the Carbondale, is not as old as the base of the Allegheny, but that that horizon is approximately marked in Illinois and western Kentucky by the Curlew limestone member, in which case that part of the Tradewater between the Curlew limestone member and the Murphysboro coal might also reasonably be regarded as of Allegheny age.

CARBONDALE FORMATION

Name and distribution.—The Carbondale formation was named from Carbondale, Jackson County, Illinois. The formation extends from the bottom of the Murphysboro coal to the top of the Herrin coal. The Carbondale formation outcrops around the outer margins of Eagle Valley. It also underlies practically all of the area north and west of the Shawneetown fault.

Character.—The Carbondale formation is made up of shale, sandstone, a very little limestone and several persistent and valuable coal beds. It is the principal coal-bearing formation of Illinois, practically all the commercial mines of the State taking their coal from one of the coal beds of the formation.

Murphysboro coal.—At the bottom of the Carbondale formation lies the Murphysboro coal of Illinois, or the Davis coal of Kentucky, so named by Lee.[19] In Illinois it is also known as the No. 2 coal and in Kentucky as No. 6 coal. It ranges from 2 to 4 feet in thickness. The roof of the Murphysboro is a black fossiliferous shale.

DeKoven coal.—A coal 15 to 55 feet above the Murphysboro coal is reported in a number of well borings and observed at a few outcrops. This is the DeKoven coal of Lee,[20] named from DeKoven, in Kentucky, where it lies 28 feet above the Murphysboro (Davis) coal.

Vergennes sandstone member.—Above the DeKoven coal or its horizon at the west end of Eagle Valley is a 30-foot sandstone, which outcrops on and gives rise to the high ridge in the east part of sec. 22, running thence north through the west side of sec. 14, T. 10 S., R. 7 E. This sandstone is regarded as the same as the Vergennes sandstone member of the Murphys-

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[19] Lee, Wallace, Geology of the Shawneetown quadrangle in Kentucky: Kentucky Geol. Survey, p. 28, 1916.
[20] Idem, p. 30.

boro-Herrin folio and the Sebree sandstone of Glenn, in Webster County, Kentucky.

Unnamed coal.—About 70 feet above the Murphysboro coal is a persistent coal which is 2 to 4 feet thick.

Lower Well coal.—About 115 feet above the Murphysboro coal is another coal, 1 to 3 feet thick, which appears to lie at the horizon of the coal in Kentucky designated by Lee[21] as the Lower Well coal.

Well coal.—This coal was so called by Owen because it was penetrated by numbers of wells in the vicinity of DeKoven, Kentucky. It is about 150 feet above the Murphysboro coal and 80 feet below the Harrisburg (No. 5) coal. It is 1 to 4 feet thick and seems to be persistent throughout the Carbondale formation in southern Illinois.

Harrisburg coal.—This coal, the principal mined coal in this part of Illinois, has long been and is still designated No. 5 coal in Illinois and No. 9 coal in Kentucky. The use of a name avoids confusion and misunderstanding, however, so it is now the practice to use the name Harrisburg coal, from Harrisburg, Illinois. The Harrisburg coal is about 230 feet above the Murphysboro coal, and is constantly 4 to 5½ feet thick throughout this area. It has a persistent black shale roof.

Briar Hill coal.—The Briar Hill coal was named by Lee,[22] from Briar Hill, near DeKoven, Kentucky. It is about 300 feet above the Murphysboro coal, and ranges in thickness from 1½ to 3 feet.

Herrin coal.—The Herrin coal is so named from Herrin, Illinois, where it is the important mining bed. It has generally been designated No. 6 in Illinois and No. 11 in Kentucky. It is about 4 feet thick in these quadrangles. A persistent feature is a clay parting about 1 foot above the bottom known as the blue band (see Pl. III). This parting is present everywhere throughout the western Kentucky and southern Illinois coal fields, and serves to identify the bed. It indicates a temporary submergence of the perfectly level coal swamp and deposition of clay after the lower 1 foot of coal matter had accumulated.

Thickness.—The thickness of the Carbondale has been determined from bore holes, with a fair degree of accuracy, to be 350 feet, a thickness from which it varies but little throughout the area.

Fossils and correlation.—The Carbondale formation has not yielded many fossils in this region, although fossils are present at a number of horizons, such as the roof shales of the Murphysboro and Harrisburg coals and thin limestones locally present above the Harrisburg coal. In the black roof shale of the coal beds the fossil shells are replaced by pyrite or marcasite and beautifully preserved, but they do not last long

[21] Idem, p. 35.
[22] Idem, p. 33.

after exposure to the air, as the pyrite or marcasite soon decomposes. A considerable collection of ferns and other plants has been made from the Murphysboro coal in the vicinity of Murphysboro. There are also in the Murphysboro quadrangle and elsewhere several horizons of marine fossils besides those in the black roof shales. Lists of the fossils are published in the Murphysboro-Herrin folio.[23] The invertebrates are mainly brachiopods, pelecypods, and gastropods, and most of them range through the upper Pennsylvanian from the upper Pottsville to the McLeansboro. From the plants, though, and the general character and relations of the formation David White concludes that the Carbondale formation is practically equivalent to the Allegheny formation of Ohio, Pennsylvania, and West Virginia, and would about correspond to the upper part of Cherokee shale of Missouri and Kansas and perhaps to some of the formations overlying the Cherokee in those regions. The Murphysboro coal, at the bottom of the Carbondale formation, is correlated by David White with the Bevier coal of Missouri, 65 to 200 feet above the bottom of the Cherokee shale, on the one hand, and with the Brookville coal, at the bottom of the Allegheny formation of western Pennsylvania, on the other hand.

MCLEANSBORO FORMATION

Name and distribution.—The McLeansboro formation was named from McLeansboro, Illinois. It outcrops in the middle of Eagle Valley, and occupies a large area north of the Shawneetown fault, mainly in the Shawneetown quadrangle, where it outcrops in the entire area of the Shawneetown Hills. There are no good exposures of any considerable thickness of the formation in the area, although there are partial exposures in the Shawneetown Hills north of Shawneetown and along the river shore at Shawneetown at time of low water. Much information about the formation is derived from well borings.

Character.—The McLeansboro formation is composed principally of thick and thin beds of sandy shale and sandstone. There is a little limestone and very little coal. The following section, from bore holes, and quoted from Lee,[24] describes adequately the character of the formation. The upper half of the section is from the log of a well near Henshaw, Kentucky, about 7 miles southeast of Shawneetown, supplemented at top by 33 feet obtained from surface observations in the vicinity; the lower half is a well log north of Sturgis, Kentucky, about 15 miles southeast of Shawneetown.

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[23] Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), 1912.

[24] Lee, Wallace, Report on the Shawneetown quadrangle in Kentucky: Ky. Geol. Survey, p. 41, 1916.

Section of the McLeansboro formation in southeastern Illinois and adjacent areas

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Shale, micaceous, sandy	6	..	6	..
Coal (Geiger Lake)	3	..	9	..
Not exposed, probably sandy shale	60	..	69	..
Black shale	4	6	73	6
Fire clay and shale	12	2	85	8
Coal	1	10	87	6
Bastard lime	4	7	92	1
Fire clay and soapstone	10	2	102	3
Sandy shale and soapstone	44	..	146	3
Sand rock and shale	12	..	158	3
Light shale	15	6	173	9
Sand rock	67	..	240	9
Dark sandy shale	80	..	320	9
Light slate	13	..	333	9
Black slate	5	5	339	2
Coal	..	4	339	6
Fire clay	9	8	349	2
Light shale	8	..	357	2
Light sandy shale	14	..	371	2
Dark sandy shale	13	..	384	2
Sandy shale	34	..	418	2
Slate and shale	4	..	422	2
Fossiliferous slate	..	2	422	4
Black slate	..	2	422	6
Coal	..	6	423	..
Fire clay	7	2	430	2
Fire clay and shale	11	..	441	2
Black slate	12	..	453	2
Coal	..	9	453	11
Fire clay	1	3	455	2
Light shale	16	6	471	8
Coal	..	2	471	10
Fire clay	4	4	476	2
Fire clay and slate	6	..	482	2
Dark shale	1	..	483	2
Sandy shale	12	..	495	2
Dark sandy shale	13	..	508	2
Dark shale	11	6	519	8
Shale and slate	6	6	526	2
Limestone, exposed at Grundy Knob (New Haven limestone (?) of Illinois Geological Survey	7	6	533	8
Black slate	1	6	535	2
Coal	..	5	535	7
Fire clay	5	7	541	2
Sandy shale	22	..	563	2
Dark shale	6	..	569	2
Slate and shale	4	..	573	2

Section of the McLeansboro formation in southeastern Illinois and adjacent areas
—Concluded

Description of strata		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Slate with coal streaks		..	6	573	8
Fire clay		..	2	573	10
Sandy shale		28	4	602	2
Sandy shale, dark		4	..	606	2
Dark shale		8	..	614	2
Shale		25	..	639	2
Black shale		5	..	644	2
Blue shale		15	..	659	2
Conglomerate		2	..	661	2
Sandy shale		78	..	739	2
Blue shale with hard bands		30	3	769	5
Coal		..	7	770	..
Fire clay		2	..	772	..
Sandstone		1	2	773	2
Shaly sandstone		19	..	792	2
Shale with limestone partings	Carlinville limestone member?	20	..	812	2
Shale		10	..	822	2
Limestone		5	..	827	2
Shale		7	6	834	8
Coal		..	4	835	..
Sandy shale		32	2	867	2
Blue shale		11	..	878	2
Dark shale		4	..	882	2
Coal		..	9	882	11
Fire clay		13	9	895	8
Dark shale		15	..	910	8
Shale with hard bands		28	..	938	8
Tough blue shale with hard bands		23	5	962	1
Coal		1	8	963	9
Dark shale		2	11	966	8
Gray shale		2	..	968	8
Hard limestone	Girtyina limestone? of the Illinois Geological Survey	7	..	975	8
Limestone with shale partings		9	..	984	8
Limestone		2	..	986	8
Blue shale with hard bands		8	..	994	8
Coal (doubtful)		..	3	994	11
Limestone		1	6	996	5
Top of Herrin or No. 11 coal of Carbondale formation in Kentucky					

There are 11 coal beds in the formation as developed in Kentucky, but only 3 are considered workable. One of these, 1 foot 8 inches thick, is 32 feet above the bottom; a second, 1 foot 10 inches thick, is 85 feet below the top; and the third, 3 feet thick and named the Geiger Lake coal, is 6 feet below the top. The latter two beds, however, are not present in this region, in which the upper half of the McLeansboro has been eroded away.

Anvil Rock sandstone member.—At or a few feet above the base of the McLeansboro, varying in position locally, is a widely distributed thick to massively bedded sandstone 20 to 60 feet thick which was named by Owen from Anvil Rock, a conspicuous isolated rock mass 1½ miles northwest of DeKoven, Kentucky. This sandstone thins out eastward, and is not reported in the section at Sturgis quoted above. It is persistent throughout the part of Illinois here described, and is well exposed almost anywhere on the hills where it is mapped. It is either directly above and in contact with the Herrin coal or as much as 20 feet above it, being separated from the coal by limestone or shale or both.

A few beds of limestone are recorded in the well logs. The limestone just above the Herrin coal, the Girtyina limestone of the Illinois Geological Survey, is of local occurrence in Eagle Valley and is persistent westward in Saline County. Another limestone in Grundy Knob, Kentucky, 5 miles northeast of Shawneetown, seems to be the same as the New Haven limestone of the Illinois Survey, which is exposed on the bluff above Long Pond, 3 miles north-northeast of Shawneetown, where it is about 20 feet thick. A few other limestone beds are reported, but none seem to be known from surface observations in this region.

The limestone above the Herrin coal and that on Grundy Knob carry marine fossils, and probably other limestones do also. These marine limestones attest the temporary submergence of the Illinois region by sea water from time to time.

Thickness.—The full thickness of the McLeansboro formation is nearly 1000 feet, but only about half of this thickness is present in the area covered by this report, extending up to and a little above the New Haven (?) limestone or the limestone of Grundy Knob, which according to Lee is 465 feet above the bottom of the McLeansboro.

Fossils and correlation.—As in the case of the Carbondale formation, no fossils have been collected from the McLeansboro in this area. A considerable number of marine invertebrates have been collected from the formation in the Murphysboro and Herrin and Springfield and Tallula quadrangles, and are listed in the folios covering those quadrangles. [25, 26]. Of 43 species from the McLeansboro listed in the Springfield-Tallula folio, 35 species occur in the Conemaugh formation of Ohio, as listed by Mark.[27]

[25] Shaw, E. W. and Savage, T. E., U. S. Geol. Survey Atlas, Murphysboro-Herrin folio (No. 185), 1912.

[26] Shaw, F. W. and Savage, T. E., U. S. Geol. Survey Atlas, Tallula-Springfield folio (No. 188), 1912.

[27] Mark, Clara Gould, Conemaugh formation in Ohio: Geol. Survey of Ohio, pp. 261-326, 1912.

On the basis of this community of fossil species the McLeansboro is confidently correlated with the Conemaugh of Ohio and Pennsylvania.

GREAT UNCONFORMITY AT TOP OF PENNSYLVANIAN SYSTEM

The McLeansboro is the youngest formation of Paleozoic age that has escaped removal in the ages of erosion that have elapsed since the region became land. There are now no rocks of Mesozoic age in the region and no rocks of Cenozoic age except a deposit of gravel a few feet thick supposed to be of late Tertiary age, described below, so that a vast period of time is unrepresented by deposits in the region.

TERTIARY (?) GRAVELS

Distribution.—So far as known the Tertiary (?) gravels are present only in the Shawneetown Hills, in the northeastern part of the Shawneetown quadrangle, where they occupy a position near the top of the hills and very nearly 500 feet above sea level.

Character.—These gravels are composed largely, if not wholly, of chert and vein quartz, the chert being fossiliferous and plainly derived from some of the Mississippian limestones of Ohio Valley. As specimens of Lithostrotion occur, part of the chert is derived from the St. Louis limestone. The pebbles are fairly well rounded and highly polished, and a great proportion of them oxidized to a dark yellowish color. Gravel of the same character and occupying a similar position near the tops of the hills in southern Pope County, approximately 500 feet above sea level, are undoubtedly a detached area of the same sheet of gravel as that on the Shawneetown Hills.

Thickness.—The gravel deposit is only a few feet thick, perhaps 10 to 20 feet.

Correlation.—Similar gravel deposits are known elsewhere in Ohio Valley in Kentucky and Indiana, and they may be detached parts of one or more large sheets of gravel accumulated on an old worn-down land surface or peneplain of late Tertiary age, and since elevated to the present levels of the gravels and dissected by erosion of deep valleys, leaving the interstream areas with their present capping of gravel. So far as observed these gravel deposits lie directly upon the solid rocks of Pennsylvanian or Mississippian age and where covered at all, it is by the loess, yet to be described. There is thus a great unconformity at the base of the gravels, measured by the thickness of all the rocks of the Permian period of the Paleozoic era, by all the rocks of the Mesozoic era and by all the rocks of the Cenozoic era older than the gravel deposits themselves.

PLEISTOCENE AND RECENT SYSTEMS

GENERAL STATEMENT

The Pleistocene and Recent deposits include all those, of whatever origin, that have been laid down since the beginning of the general glaciation that prevailed from time to time in the temperate zones and that still exists in the Arctic regions and on high mountains. In these quadrangles the Pleistocene deposits include loess and lake beds.

LOESS

Distribution.—In the area undoubted loess occurs principally on the top of the Shawneetown Hills, north of Shawneetown. There may be

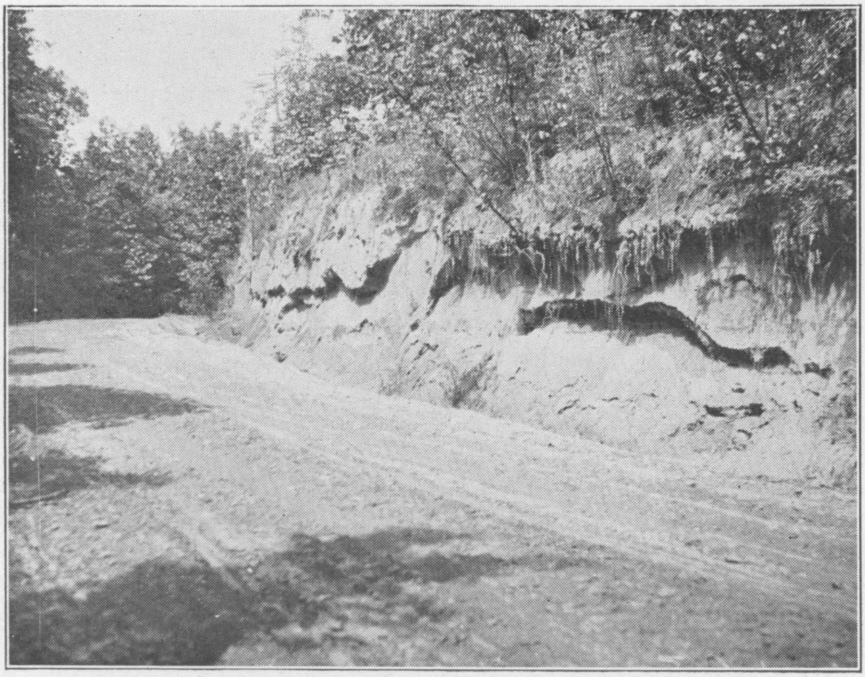

Fig. 3. Loess in road 3 miles north of Shawneetown, Ill. Looking south.

other areas, but the Shawneetown area is the only one seen where the deposit has the unmistakable characteristics of genuine loess. A considerable part of the area is covered with a mantle of material similar to the loess, and much of it may be loess, which has perhaps been washed down the slopes and mixed with material derived from the rocks underlying the surface, so that its original character has been somewhat obscured. Much soil of considerable depth, derived from the decay of limestone and shale and fine sandstone, has a loess-like appearance, so that it would require a close examination to determine whether the deposit is loess or residual soil. It was not, therefore, determined whether the soil mantle of the quadrangles generally is genuine loess or not.

Character and thickness.—The loess is an extremely fine, compact earth, so fine that it is without particles big enough to scratch the fingers when rubbed between them. Notwithstanding its extreme fineness and softness, the deposit is so compact that exposures stand up in persistent vertical walls, instead of crumbling, as a bank of sand, or slumping to a slimy bank, like a bed of clay. (See fig. 3). The thickness of the loess on the Shawneetown Hills seems to be 20 to 30 feet.

Origin and age.—The loess of this region overlies the Tertiary (?) gravels, and probably none of it is older than Pleistocene. In other parts of Illinois a bed of loess is overlain by deposits of the latest or Wisconsin stage of glaciation, and it is almost certain that some of the loess in these quadrangles is of pre-Wisconsin age. From its manner of origin, as described above, its deposition has almost certainly continued down to the present, so that it is of both Pleistocene and Recent age.

Loess is known to be a deposit of fine dust which has been blown by the wind from varying distances and then deposited from the air, from which it settled down over the surface as snow does. Such deposits in China, thousands of feet thick, are known to have been carried there by the wind from the deserts of central and western Asia. The loess of Mississippi and Ohio valleys is believed to have been derived mainly from the river beds at times of low water, and from the wider alluvial flats bordering the rivers when they were bare of vegetation or but scantily covered with vegetation after the glacial stage. The finer material of the river banks and alluvial plains was caught up by the winds and transported to higher ground and there dropped upon the surface. By long continuance of this operation the loess beds were accumulated. The efficacy of the wind as an agent to accomplish the work may be judged from the great clouds of dust that at the present day are raised and transported by the winds among the rivers.

LAKE BEDS

Distribution.—The glacial lake beds are widely distributed in southern Illinois and western Kentucky. They occupy the valleys of Tradewater River, Cypress Creek in Kentucky, a wide belt along Ohio River above the narrow part of the valley above Battery Rock, Illinois, and Caseyville, Kentucky, a considerable part of Eagle Valley, and all of the part of the area north of Gold Hill, Wildcat Hills, and west of Cave Hill except the row of low hills near the northern border of the Equality quadrangle.

Character.—The lake beds are made up of clay, mud, sand and gravel. The following sections from the logs of bore holes will illustrate the character of the deposits.

Section of lake beds 2 miles west of Shawneetown

	Thickness *Feet*	Depth *Feet*
5. Clay	13	13
4. Sand and clay	22	35
3. Sand	49	84
2. Clay	24	108
1. Sand	29	137

Section of lake beds 1 mile east of Equality

	Thickness *Feet*	Depth *Feet*
4. Surface	7	7
3. Sand	2	9
2. Clay	20	29
1. Blue mud	38	67

Section of lake beds on Little Eagle Creek 3 miles west of Leamington

	Thickness *Feet*	Depth *Feet*
2. Clay	12	12
1. Sand and gravel	55	67

Section of lake beds in extreme northwest corner of Equality quadrangle

	Thickness *Feet*	Depth *Feet*
4. Surface	19	19
3. Sand and gravel	5	24
2. Mud, blue	10	34
1. Gumbo, dark	39	73

In one well gastropod shells were reported at the depth of about 100 feet.

Thickness.—The thickness of these deposits may vary from 137 feet, as in the first section above, to a few feet, where they are no thicker than ordinary residual soil. This variation in thickness is explained under the description of the manner of origin of the beds.

Age and origin.—The lake beds of this area accumulated at the time of the latest or Wisconsin stage of glaciation, and are of Wisconsin age. They were deposited in water, which flooded all the valleys of southern Illinois and western Kentucky far up toward their heads. This flooding was caused by the filling of the bed of Ohio River with sand and gravel in the latest glacial advance to a level of about 400 feet. The river valley filled because the river received more material from the melting rivers to the north than its water could transport. This filling naturally acted as a dam to the tributary streams, the valleys of which were flooded to the level of the filling in Ohio Valley. In these lakes the clay, mud, sand, and gravel from the surrounding higher grounds accumulated until the lakes were filled to about the 380-foot level, forming the present level lands of Ohio, Saline, and Eagle valleys. The varying thickness of the lake beds is due to the uneven surface on which they were deposited, as the old valleys had an uneven surface, just as does the valley of the present time.

A factor in the flooding of Saline Valley is doubtless the constriction of the river opposite Caseyville by the resistant conglomerate which descends to and below water level in that part of the river valley. With a greatly increased volume of water this constriction would naturally cause a ponding above the constriction, and the consequent deposition of the material brought down from the glaciated areas to the north at times of melting of the glacial ice.

Since the end of glacial time the rivers and streams have been actively eroding their channels into the lake mud or river gravel and sand. Contemporaneously with this activity the loess deposits have been formed.

ALLUVIUM

The alluvium is mainly silt and sand that have been deposited along the streams and at the foot of the slopes in Recent time. The deposits are thin and generally confined to small strips along one or both sides of the stream. Besides the stream alluvium, much fine material, including small rock fragments, has been washed down from the slopes of the higher ground and spread out over the surface of the lake beds at the foot of the hills.

As the character of the alluvium is essentially the same as that of the lake beds, its representation by a separate color and symbol on the map is somewhat arbitrary.

WIND BLOWN SAND

Distribution.—Notable deposits of sand overlie the lake beds in two areas and even extend up on the higher ground. The principal area is a belt about 1 mile wide along the northwest-west side of Shawneetown Hills. The sand extends west as far as Junction, and is so thick in the road southwest and northeast of that place as to make passage difficult. At its south end this belt extends up to the top of the west end of Gold Hill. Another area is on the northeast side of Saline River, where it occupies an area of considerable size in the SE. ¼ sec. 17 and the SW. ¼ sec. 16, T. 10 S., R. 9 E.

Origin.—These sand deposits appear to be traceable into a thick deposit of sand overlapping the northwest side of the Shawneetown Hills to a height of 50 or 100 feet. The original source of the sand in this deposit and the manner of its accumulation are unknown, but it is conceivable that it was derived from Ohio River to the northeast of the Shawneetown hills and was blown southwestward by the wind in the manner of a sand dune. From this as a secondary source, the sand of the surficial thin deposits above described was derived and was distributed by the northeast winds essentially in the manner in which the sand of dunes is transported.

Igneous Rocks

To the south of this area, in Hardin County, igneous rock, (peridotite or lamprophyre), in the form of dikes, plugs, or sills, is known at several places. Dikes of the same kinds of rocks have been encountered in some of the mines in the Harrisburg district, as described by Cady in his report on the coals of that district.[28] One of these dikes is 50 feet thick. The rock is identified as a kersantite. From the occurrence of such igneous rock on both sides it is probable that dikes or sills of the same rock occur in the sedimentary beds of this area, although none have been found in outcrop, a circumstance that is easily explainable, from the fact that such rock decays readily under the action of the weather, and so does not outcrop under ordinary conditions, but is generally revealed in artificial cuttings, or, rarely, in recent natural exposures, as on a river bluff.

Structure

Definition

By structure as used in this report is meant the attitude or lay of the strata, which were originally horizontal but now, over most of this area, are inclined at various degrees, and broken and dislocated by faults. The inclined rocks lie in folds, the upward bending folds being anticlines or domes and the downward bending folds being synclines. The breaks and dislocations are faults. These structures are illustrated by the structure sections on the geologic map. Through erosion the crests of the anticlines have been worn off and the inequalities due to the faults have been obliterated, so that no indications of these structures now remain in the surface of the country. It is only by the observation of the strata themselves that these structures are discovered.

In addition to these mass structures the rocks have texture, such as coarse or fine grain. They are in layers of greater or less thickness, separated by bedding planes, and are, like rocks generally, intersected by one or more sets of crevices, called joints, cutting across the bedding.

The structure is represented by structure sections, which show the lay of the strata as it would appear in a deep trench across the country, and by

[28] Cady, G. H., Coal resources of District V: Ill. Coal Mining Investigations Bull. 19, p. 56, 1919.

structure contours, which are lines supposed to be drawn upon the surface of some stratum, each line passing through points upon the chosen surface having the same distance above sea level. For example, a line is drawn through all points on the top of the Harrisburg (No. 5) coal at 500 feet above sea, another at 450, and another at 550, and so on. By the combined effect of these lines the lay or shape of the top of the Harrisburg coal throughout the quadrangles is shown. All other strata being nearly parallel to the coal their lay or shape is also represented.

The main structural features of the region are the Eagle Valley syncline and the Shawneetown fault. Minor structures are the small folds in the southwestern part of the area, which seems to be the continuation of the Shawneetown fault. Other faults are in the Eagle Valley syncline at the north end of Cave Hill and in the north part of the Equality quadrangle.

It will not be necessary to describe all these structures in detail, but some of their more important features will be pointed out. The details can be determined from the map.

DESCRIPTION OF STRUCTURAL FEATURES

EAGLE VALLEY SYNCLINE

The Eagle Valley syncline is a deep trough extending eastward across the southern part of the area. At its western end it turns sharply southward, narrows to a point, and dies out southwest of Herod, in northeastern Pope County. It is deepest and widest immediately west of Ohio River, and becomes constantly narrower and shallower westward. It is crossed near the middle by the Grindstaff and Saline River faults, which interrupt the eastward descent of the strata and cause a repetition of the outcrop of the Anvil Rock sandstone and the Herrin coal just east of Saline River. The syncline is bounded on the north by the Shawneetown fault, north of which the rocks dip northward.

On the south limb of the syncline the rocks dip north at an angle of approximately 5° while on the north side, in the Wildcat Hills, the strata dip south at an average angle of 20°. The bottom of the syncline is rather flat and the location of the axis is in parts very indefinite, as between Saline and Ohio rivers. The Eagle Valley syncline is of special importance, because it holds a large body of coal in the different beds of the Carbondale formation, as described in the chapter on Economic Geology.

SHAWNEETOWN FAULT

Along the north side of Gold Hill and the Wildcat Hills the strata are downthrown as much as 2300 feet in secs. 27 and 28, T. 9 S., R. 8 E., where beds on the north of the fault at least as high as the top of the

Tradewater are dropped down into contact with the Ste. Genevieve limestone, stratigraphically as much as 2300 feet below the top of the Tradewater. For a mile or more north of Horseshoe Gap, 3 miles southwest of Equality, where the Shawneetown fault crosses the north end of the lozenge-shaped upthrown fault block at the north end of Cave Hill, the relative downthrow on the Shawneetown fault is not less than 3500 feet, and may be much greater, as rocks as old as Ordovician may be in contact with the Tradewater beneath the cover of the lake beds. This conclusion is based upon the possibility that the vertical dip persists within

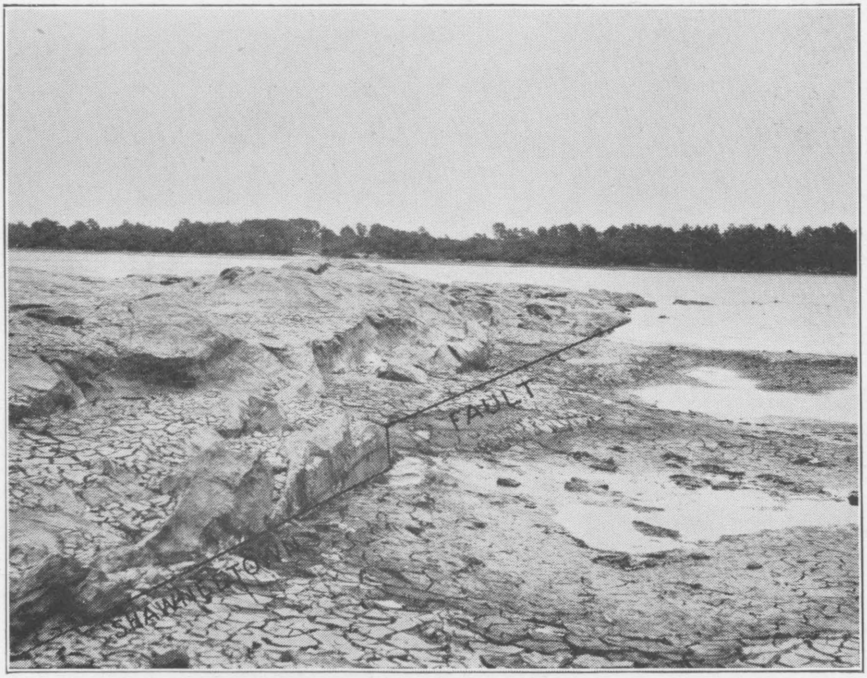

Fig. 4. Fault between McLeansboro and Caseyville formations on shore of Ohio River at Shawneetown. Looking east.

the fault block to the northeast of the small area of vertical Osage limestone outcropping upon the small knoll half a mile northwest of Horseshoe Gap. Southwestward the Shawneetown fault, after turning sharply southward, passes into an anticline with dip on the west of the axis as great as 60° west, but diminishing to 5 or 10° half a mile northwest of the axis. The rocks are greatly disturbed all along this fault, by crushing and subordinate faulting, so that it is not a single simple fracture but a compound one extending over a belt of considerable width. (See Structure section C-C at the east end of Gold Hill for hypothetical structure in this belt.) The

Fig. 5A and 5B. Slickensided and brecciated Caseyville sandstone. Shore of Ohio River at Shawneetown a short distance south of fault shown in figure 4. Looking west.

crushing is also displayed at Shawneetown, where the rocks adjacent to the fault are clearly exposed on the river shore. (See figures 4, 5A and 5B.) The compound nature of the fault is displayed by the double fault at the north base of the Wildcat Hills and by the subordinate faults at the north end and west side of Cave Hill. The rocks in the fault blocks in that locality are tilted steeply to the southeast, and in places are vertical, as in the SW. ¼ sec. 34, T. 9 S., R. 7 E., and the NW. ¼ sec. 3, T. 10 S., R. 7 E., and in the knoll half a mile northwest of Horseshoe Gap. The lozenge-shaped block between the two subordinate faults diverging from the Shawneetown fault northeast of Horseshoe Gap is relatively upthrown and tilted to the southwest. The structure in this fractured and tilted area is shown on the areal geology map (Pl. I) by dip symbols and structure sections, and on the detail map, Plate II, by a number of cross sections. The Shawneetown fault has been traced eastward entirely across the western Kentucky coal field, and named the Rough Creek fault in that State, from Rough Creek in Ohio and Breckinridge counties. The same belt of disturbance extends even south of the Blue Grass region into the eastern Kentucky coal field.

OTHER FAULTS

The Saline River fault is inferred from the fact that the Herrin coal is 86 feet above sea level in sec. 1, T. 10 S., R. 8 E., while in the ridge west of Bowlesville, 2 miles east, it reaches 500 feet above sea level, and in the bottom of the Eagle Valley syncline in sec. 17, T. 10 S., R. 9 E., it is probably about 300 feet above sea level or 214 feet higher than in sec. 1 west of Saline River, just mentioned. The strata seem to be upthrown about 200 feet on the east of the fault. The Grindstaff fault is indicated by offset of the outcrop of the Grindstaff sandstone in Grindstaff Hollow, in sec. 28, T. 10 S., R. 8 E. and is also indicated by a bore hole in the vicinity of Leamington. The downthrow is on the west, about 200 feet in the vicinity of Leamington. The Cottage Grove fault, in the northwestern part of the Equality quadrangle, is of importance because of the bearing on the distribution and mining of the coal beds in that locality. It is certainly present between the center of sec. 15, T. 9 S., R. 7 E. and the north line of that section, and it is supposed to extend west-northwest to connect with a small fault 2 miles northwest of Harrisburg in sec. 2, T. 9 S., R. 6 E., which trends east-southeast in the direction of Cottage Grove. South of Cottage Grove the downthrow is 170 feet at least on the south side of the fault.

Except for a low dome revealed in mining just west of Equality the strata north and west of the Shawneetown fault or anticline, so far as known, dip north and northwest at a nearly uniform rate of about 100 feet to the mile. In the Hickory Hill mine the total dip from the mine mouth to the north end of the main slope, a distance of 1¼ miles, is 125 feet.

CHAPTER III—ECONOMIC GEOLOGY

Introduction

The mineral resources of this area consist in order of their importance, of coal; limestone for lime, cement, road metal, and fertilizer; chert for road metal and ballast; shale for brick and tile; and possibly sand for mortar.

Coal

occurrence

Coal beds occur in all of the Pennsylvanian formations of the area although none of importance has been observed in the Caseyville sandstone. In the Tradewater formation 15 coal beds are known which are well distributed throughout the entire formation. Most of them are probably impersistent, each occurring as thin lenses of small extent here and there at its proper horizon. Only one bed, the Willis, which is probably the same as the Bell coal of Kentucky, is known to be of minable thickness, and that only within a small area. The commercially important coal beds of the region are in the Carbondale formation. Of these only one, the Harrisburg (No. 5) coal, which is the most important bed in the region has been mined in this area on a commercial scale.

The stratigraphic distribution of the coal beds is shown in the generalized columnar section on the geologic map, and the character of the individual beds is shown in the sections of Plate III.

coals of the tradewater formation

willis coal

The Willis coal, in the lower part of the Tradewater formation was named from the Willis property, in sec. 30, T. 10 S., R. 9 E., where it is mined for local use. At the Willis mines it is directly underlain by the Grindstaff sandstone member and immediately overlain by a sandstone about 40 feet thick, which may represent the Finnie sandstone of Owen in Kentucky. Its stratigraphic relations indicate that it is the same as the Bell coal of Kentucky, but as it cannot be certainly identified with that coal a local name is used. The Willis coal has been identified by Cady as the Ice House bed of Owen in Kentucky. The writer, however, is inclined to correlate it with the Bell coal of Kentucky, which, like the Willis, so far as known, is the second bed above the top of the Caseyville formation. As shown below, too, there is above the Willis coal in the same locality a bed, probably 2 feet thick, that would correspond in position to the Ice House bed. It may be mentioned here also that in the same table of analyses, and in figure 5 of the Illinois Mining Investigations bulletin[1], the Murphysboro (Davis and DeKoven) coals at Colbert's mines, in secs. 23 and 26, T. 10 S., R. 7 E., are identified as the Bell and Ice House coals, respectively.

At the Willis mines the Willis coal is 2 feet 9 inches and 3 feet 6 inches thick clear coal. (See Nos. 1 and 2, Pl. III.) It has a solid sandstone roof and a clay floor several feet thick resting upon the Grindstaff sandstone. The Willis coal has also been opened at what appears to be the old Boswell mine in Clayton Hollow, in the SE. ¼ NW. ¼ NE. ¼ sec. 26, T. 10 S., R. 8 E. The height of the opening at the old mine indicates a thickness of 2 to 3 feet. At a nearby point in the same ravine 20 inches of clear, bright coal was uncovered, but the bottom was not reached. Still farther west, in a ravine on the east side of Grindstaff Hollow, in the SW. ¼, NW. ¼ sec. 27, T. 10 S., R. 8 W., 18 inches of the coal was seen at an old opening. The Willis coal, therefore, is of workable thickness along an outcrop 4 miles in length, and a considerable body of workable coal is indicated in the locality. If it averages 2½ feet thick over an area of 4 square miles, it contains 11,520,000 tons of coal. The Willis coal is of excellent quality as shown by analysis No. 1, Table 3.

UPPER WILLIS COAL

At the Willis place a coal has been opened that seems to be about 100 feet above the Willis. This is here called the Upper Willis coal. It may be the same as the Ice House coal of Kentucky. At an opening in the NE. ¼ SW. ¼ sec. 30, T. 10 S., R. 9 E., about 2 feet of coal was visible, and this was judged to be about the full thickness. At an old mine now completely closed on the Peter Frick property, near the center of the NW. ¼ of the same section, a thickness of 3 feet 4 inches of coal was reported by a resident of the locality. This coal is probably the Upper Willis bed.

COALS OF THE CARBONDALE FORMATION

MURPHYSBORO (DAVIS-DEKOVEN) COAL

The Murphysboro, a single bed in places in the vicinity of Murphysboro, Illinois, has been reported to split into two beds eastward in Saline and Gallatin counties and in western Kentucky, as shown in a bulletin of the Illinois Geological Survey.[2] In Eagle Valley the two parts or benches are 30 to 40 feet apart, and in western Kentucky as much as 60 feet apart.

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[1] Cady, G. H., Coal resources of District V: Ill. Mining Investigations Bull. 19, p. 37 and 38, 1919.

[2] Idem, Plates II, III and VI.

In the Illinois report referred to they are called the "lower bench No. 2" and "upper bench No. 2" or Murphysboro coal "four foot" (lower) and Murphysboro coal "three foot" (upper). The lower bench was named the Davis coal and the upper bench the DeKoven coal by Lee in his report on the Shawneetown quadrangle in Kentucky,[3] and those names are for convenience adopted here. The best exhibition of these coals in the area is at Colbert's mines, in secs. 23 and 26, T. 10 S., R. 7 E., as shown in the following section. Both coals are opened in the same hillside within a short distance of each other.

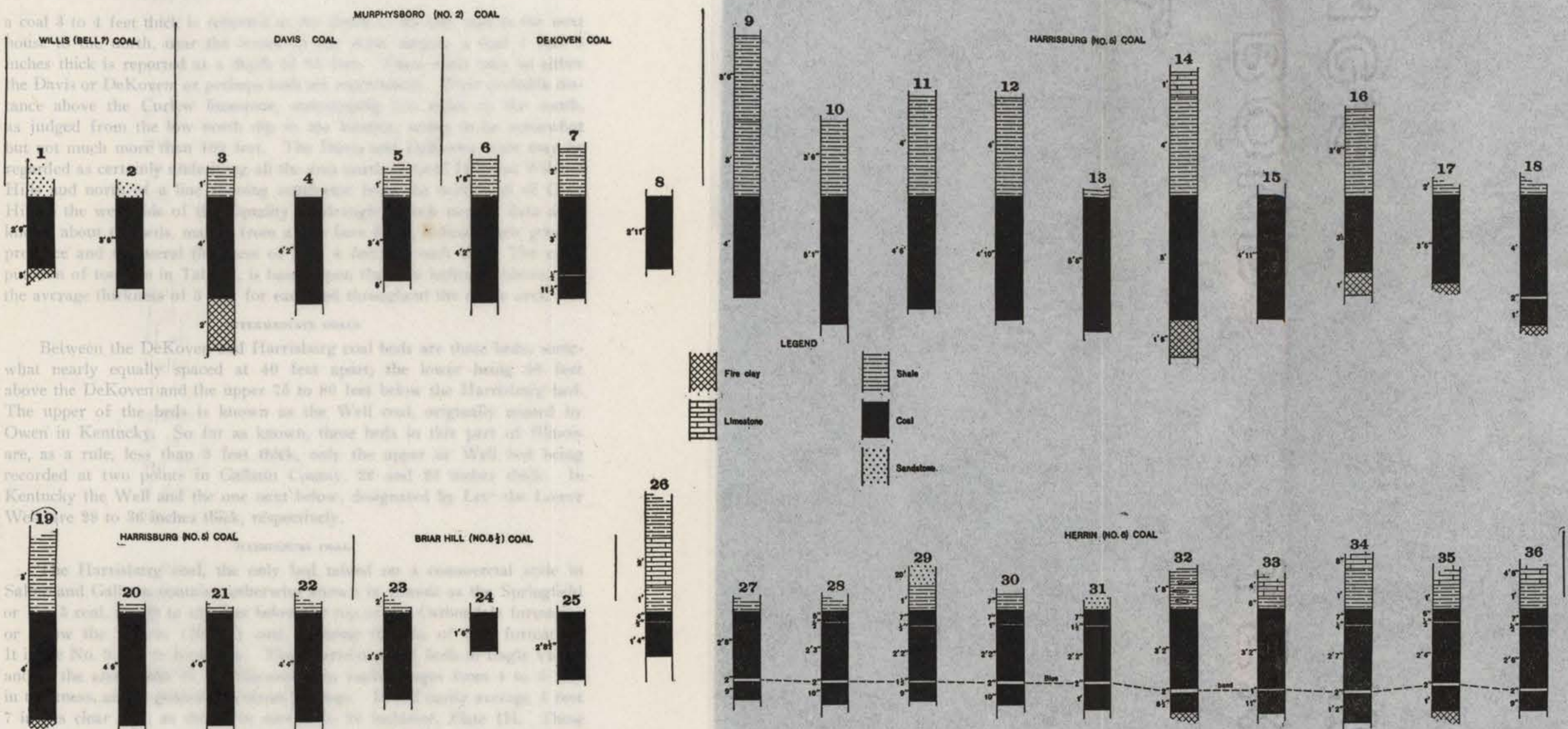
Section of Davis and DeKoven coal as exposed in Colbert's mines in secs 23 and 26, T. 10 S., R. 7 E.

	Thickness	
	Ft.	*In.*
Shale, dark	6	..
Shale, black	1	6
Coal, clear (DeKoven)	4	2
Not exposed	5±	..
Sandstone, thick bedded	25	..
Not exposed	25	..
Coal (Davis)	4	..
Clay	2	..
Sandstone	1	..
Clay	4	..

The outcrop of these coals can be traced, by old mines, pits, or natural exposures, from Colbert's mines along the south side of Eagle Valley to the knob half a mile south of Saline Mines in secs. 34 and 35, T. 10 S., R. 9 E., and they reappear in Kentucky from beneath the filling of Ohio River at points in direct continuation of their outcrop in Illinois. The points at which they have been observed or are known from mining are shown by the pit symbols on their outcrops. The outcrop can be followed less satisfactorily around the west end and north side of Eagle Valley, but the Davis is well exposed in sec. 2, T. 10 S., R. 7 E., and there is an old opening on the Davis or DeKoven on the Lewis Grator farm, in the NW. ¼ NE. ¼ sec. 34, T. 9 S., R. 8 E. From the last described point to Ohio River nothing is known of either bed on the north side of Eagle Valley.

All definite data regarding these coals in Eagle Valley is shown on Plate III, secs. 3 to 5 for the Davis coal and secs. 6 to 8 for the DeKoven coal. In Saline Valley west of Cave Hill a coal bed was once opened in the SW. ¼ SW. ¼ sec. 4, T. 10 S., R. 7 E., and was reported to be 2 feet 10 inches thick, and in a well at the house just east of the highway in the middle of sec. 5, T. 10 S., R. 7 E., near the south line of the section,

[3] Lee, Wallace, Geology of the Kentucky part of the Shawneetown quadrangle: Ky. Geol. Survey, 1916.



1. Willis mine, SE. ¼ SW. ¼ sec. 30, T. 10 S., R. 9 E.
2. Willis mine, cen. SE. ¼ sec. 30, T. 10 S., R. 9 E.
3. Colberts mine, NE. ¼ NW. ¼ sec. 26, T. 10 S., R. 7 E.
4. Barnett farm, SE. ¼ sec. 17, T. 10 S., R. 8 E.
5. NW. ¼ SE. ¼ sec. 2, T. 10 S., R. 7 E.
6. Colberts mine, SW. ¼ sec. 23, T. 10 S., R. 7 E.
7. Morgan farm, NW. ¼ NE. ¼ sec. 19, T. 10 S., R. 8 E.
8. Barnett farm, SE. ¼ sec. 17, T. 10 S., R. 8 E.
9. Dennison mine, SE. ¼ NW. ¼ sec. 11, T. 10 S., R. 7 E.
10. Tarleton mine, E. side SE. ¼ sec. 13, T. 10 S., R. 7 E.
11. Osborne mine, NE. ¼ SE. ¼ sec. 13, T. 10 S., R. 7 E.
12. Booten mine, NW. ¼ SE. ¼ sec. 18, T. 10 S., R. 8 E.
13. Ratten mine, SW. ¼ NE. ¼ sec. 17, T. 10 S., R. 8 E.
14. Blacks mine, NE. ¼ sec. 23, T. 10 S., R. 8 E.
15. Saline mine, SE. ¼ SE. ¼ sec. 27, T. 10 S., R. 9 E.
16. Road ⅓ mile south of Horseshoe Gap, SE. ¼ SE. ¼ sec. 36, T. 9 S., R. 7 E.
17. SE. ¼ sec. 33, T. 9 S., R. 8 E.
18. NE. ¼ sec. 26, T. 9 S., R. 7 E.
19. NW. ¼ NE. ¼ sec. 26, T. 9 S., R. 7 E.
20. Equality East End mine
21. Equality West End mine
22. Sanks mine, Hickory Hill, SW. ¼ SW. ¼ sec. 14, T. 9 S., R. 8 E.
23. Hine mine, SE. ¼ sec. 18, T. 10 S., R. 9 E.
24. Moores farm, SE. ¼ SE. ¼ sec. 22, T. 9 S., R. 7 E.
25. Equality railroad station
26. Jones school on line between secs. 11 and 12, T. 10 S., R. 7 E.
27. Purcells mine, SW. ¼ SW. ¼ sec. 10, T. 10 S., R. 8 E.
28. Greens mine, NW. ¼ NE. ¼ sec. 15, T. 10 S., R. 8 E.
29. Bentleys mine, SE. ¼ sec. 13, T. 10 S., R. 8 E.
30. Keasleys mine, SE. ¼ NW. ¼ sec. 5, T. 10 S., R. 8 E.
31. Strickland farm, SE. ¼ sec. 33, T. 9 S., R. 8 E.
32. Dukes mine, cen. sec. 8, T. 10 S., R. 9 E.
33. Strong mine, Bowlesville, NW. ¼ sec. 9, T. 10 S., R. 9 E.
34. Carnes mine, NW. ¼ SE. ¼ sec. 22, T. 10 S., R. 7 E.
35. Equality old mine, SW. ¼ sec. 16, T. 9 S., R. 8 E.
36. Equality Sisk mine, SW. ¼ SW. ¼ sec. 16, T. 9 S., R. 8 E

Sections of coal beds in Equality-Shawneetown area

a coal 3 to 4 feet thick is reported at the depth of 65 feet, and at the next house to the north, near the center of the same section, a coal 4 feet 8 inches thick is reported at a depth of 85 feet. These coals may be either the Davis or DeKoven, or perhaps both are represented. Their probable distance above the Curlew limestone, outcropping 1½ miles to the south, as judged from the low north dip in the locality, seems to be somewhat but not much more than 100 feet. The Davis and DeKoven coals may be regarded as certainly underlying all the area north of Gold Hill and Wildcat Hills and north of a line running southwest from the north end of Cave Hill to the west side of the Equality quadrangle. Such meager data as is known about the beds, mainly from a few bore holes, indicate their general presence and a general thickness of 2 to 4 feet for each bed. The computation of tonnage in Table 2, is based upon the area indicated above, and the average thickness of 3 feet for each bed throughout the entire area.

INTERMEDIATE COALS

Between the DeKoven and Harrisburg coal beds are three beds, somewhat nearly equally spaced at 40 feet apart, the lower being 40 feet above the DeKoven and the upper 75 to 80 feet below the Harrisburg bed. The upper of the beds is known as the Well coal, originally named by Owen in Kentucky. So far as known, these beds in this part of Illinois are, as a rule, less than 2 feet thick, only the upper or Well bed being recorded at two points in Gallatin County, 22 and 23 inches thick. In Kentucky the Well and the one next below, designated by Lee[4] the Lower Well, are 28 to 36 inches thick, respectively.

HARRISBURG COAL

The Harrisburg coal, the only bed mined on a commercial scale in Saline and Gallatin counties, otherwise known in Illinois as the Springfield or No. 5 coal, is 100 to 130 feet below the top of the Carbondale formation or below the Herrin (No. 6) coal, forming the top of that formation. It is the No. 9 coal in Kentucky. The Harrisburg bed, both in Eagle Valley and in the area north of the Shawneetown fault, ranges from 4 to 5 feet in thickness, and is generally without partings. It will easily average 4 feet 7 inches clear coal, as shown in secs. 9 to 22 inclusive, Plate III. These are sections at all localities where the bed was accessible to direct observation. Besides there are numerous bore hole records in which the bed agrees in thickness with the measured sections.

BRIAR HILL (NO. 5½) COAL

About midway between the Harrisburg and Herrin coals is a coal called No. 5½ coal in this part of Illinois and named by Lee the Briar Hill coal,

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[4] Idem.

from a locality in southern Union County, Kentucky. The Briar Hill bed is persistent, but generally only 1 to 2 feet thick, locally reaching a thickness of 2 feet 4 inches, as recorded in several diamond drill holes in the northwest corner of this area, and as exposed in the street just above the railroad station at Equality. At the Hine bank, in the SE. ¼ sec. 18, T. 10 S., R. 9 E., it is 3 feet 5 inches thick clear coal. The character of the bed is shown in secs. 23 to 25, Plate III.

HERRIN (NO. 6) COAL

The Herrin coal lies at the top of the Carbondale formation, and in this area is 100 to 130 feet above the Harrisburg coal. It is persistent throughout this area, where its horizon is beneath the surface. Its average thickness, including partings, is 4 feet in Eagle Valley and 4 feet 6 inches north of the Shawneetown fault. A characteristic feature is a persistent clay parting, about 1 foot above the bottom, known as the "blue band". This characterizes the bed in southeastern Illinois and extends into Webster County, Kentucky. There is also a persistent thinner parting about 6 to 8 inches below the top. The general character of the bed is well exhibited in secs. 26 to 36, Plate III.

AREA OF THE COAL BEDS AND AMOUNT OF COAL

The estimates of tonnage of the different coal beds are of very unequal value. Those for the Herrin and Harrisburg coals in Illinois may be accepted as reliable. The estimate of the thickness of the Davis and DeKoven coals throughout the area is of less validity. Nevertheless, it agrees with observation in Eagle Valley and in the southern part of the Shawneetown quadrangle in Kentucky. These estimates are corroborated by borings westward into Saline County, Illinois, and as far north as New Haven, in the northeastern part of Gallatin County and 15 miles nearly due north of Shawneetown. The Davis coal is at least 3 feet thick in part of Webster County, Kentucky, if not generally throughout the county. The DeKoven coal, however, thins out eastward.

It is believed that on the whole there is sufficient probability that the Davis and DeKoven coals will average 3 feet in thickness throughout the area underlain by them to warrant including them in the estimate of ultimately minable coal.

The estimates of area and total tonnage in the ground are given in Table 2, using 1800 tons per acre foot in computation.

CHARACTER OF COAL

All the coals of southern Illinois and western Kentucky are of bituminous grade. They are lower in fixed carbon and higher in volatile hydrocarbons than the bituminous coal of western Pennsylvania and of the Appalachian coal field generally. Few individual analyses of samples from the part of Illinois in these quadrangles are available. Only one analysis of the DeKoven coal and two analyses of the Willis coal have been made. Many analyses of coal from the immediately surrounding area in Saline and Gallatin counties have, however, been made for the Illinois State Geological Survey,[5] as well as by the U. S. Bureau of Mines, and the averages of these analyses afford a satisfactory knowledge of the coals of the quadrangles.

TABLE 2.—*Areas and tonnage of coal beds*

Eagle Valley

Coal bed	Area	Average thickness		Tonnage	Total tonnage
	Sq. mi.	*Ft.*	*In.*		
Davis	50	3	..	172,800,000	
DeKoven	50	3	..	172,800,000	
Springfield	40	4	7	211,200,000	
Herrin	30	3	10	132,480,000	689,280,000
North of the Shawneetown Fault					
Davis	80	3	..	276,480,000	
DeKoven	75	3	..	259,200,000	
Springfield	40	4	7	211,200,000	
Herrin	25	4	4	128,400,000	875,280,000
				Grand total	1,564,560,000

These analyses show that the older Tradewater (Pottsville) coals are somewhat higher in heating value than the younger coals, and that the Davis coal, at the bottom of the Carbondale formation, is next in grade. Also that the Harrisburg coal and, so far as shown by a single analysis, the Herrin coal of the Eagle Valley syncline south of the Shawneetown fault, are of slightly higher grade than the respective coals north of the Shawneetown fault.

As noted by Cady [6] the Harrisburg coal of Saline and Gallatin counties has the lowest moisture content of any coal in Illinois except that of Eagle Valley, and the ash of the Harrisburg coal is lower than that of any other coal in the State except the Murphysboro coal at LaSalle and Murphysboro and the Herrin coal of Franklin and Williamson counties.

MINING CONDITIONS

The coal beds of the area described have a gentle dip in most of the area, the highest dip, 20° on the outcrop, being in Eagle Valley. The dip

[5] Parr, S. W., Purchase and sale of Illinois coal under specifications: Ill. State Geol. Survey Bull. 29, 1914.
[6] Cady, G. H., Coal resources of District V: Ill. State Geol. Survey Bull. 19, p. 105, 1919.

TABLE 3.—*Table of coal analyses.*

No.	Moisture	Volatile hydrocarbons	Fixed carbon	Ash	Sulphur	Calorific value British thermal units (B. t. u.)
1	5.9	34.1	51.5	8.5	2.81	12,760
2	3.4	33.3	55.2	8.1	4.25	13,400
3	4.2	36.7	48.1	11.0	3.79	12,630
4	5.6	35.6	49.2	9.6	3.78	12,460
5	9.2	34.0	48.1	8.7	1.53	11,820

No. 1. Willis coal, Illinois average of two analyses for Illinois State Geological Survey.

No. 2. Davis coal, Eagle Valley-Colbert mine.

No. 3. Harrisburg coal. Eagle Valley syncline, Kentucky. Average of Bureau of Mines analyses 19017b to 19084b, 19169, 19170b to 191746 and 23010a.

No. 4. Harrisburg coal. Saline and Gallatin counties, Illinois. Average of 11 analyses for Illinois State Geological Survey.

No. 5. Herrin coal. Franklin and Williamson counties, Illinois. Average of 58 analyses of samples from 16 mines, for Illinois State Geological Survey.

north of the Shawneetown fault is in general about 100 feet to the mile north. The coal beds are of course displaced by the faults of the area, of which several of considerable displacement are known—the Saline Valley, Grindstaff, and Cottage Grove faults. Along the first the rocks are dropped down on the west and along the second they are down on the east, so that the area between the two faults is a down dropped block, the downward displacement being over 100 feet. Along the Cottage Grove fault the displacement is downward on the south, the amount being 150 feet or a little more in sec. 15, T. 9 S., R. 7 E.

Minor faulting, a few inches to a few feet, is common in the Harrisburg mining district, 8 to 10 miles west of Equality, and such faulting probably exists also in the Equality district and in Eagle Valley.

Also a number of dikes of igneous rocks, peridotite, kersantite and others affect the Harrisburg district. These are a few feet to 50 feet in thickness and cut the coal beds vertically or nearly so. It is not to be doubted that such dikes also exist in the region under description. The faults and dikes are described by Cady in a bulletin of the Illinois Geological Survey.[7]

The coal beds have in most parts good roof and floor. The roof is generally shale over the Harrisburg coal and shale but more extensively limestone over the Herrin beds. No special difficulties or dangers are reported from gas or water. The coal north of the Shawneetown fault can best be mined by slope or by shaft to shallow depth. Extensive areas of Harrisburg coal in the Eagle Valley syncline in Kentucky have been mined by slope, and probably all the Eagle Valley coal can be won in that way. It would seem, however, that there would be obvious advantages as respects drainage and haulage in sinking a shaft to the coal at depths of 300 feet or less near the middle of the syncline. In this connection the character of the lake beds is a factor. They are likely to cause trouble by caving, and sites should be selected where they are thin.

DEVELOPMENTS

The Harrisburg coal is mined on a commercial scale at Hickory Hill and Equality. In Eagle Valley both the Harrisburg and Herrin coals are mined for local use at several local mines but there are no commercial mines in that part of this area.

LIMESTONE

Limestone well suited for the manufacture of lime, cement, and ground rock for fertilezer, exists along the north base of Wildcat Hills and the north end and west base of Cave Hill. The Ste. Genevieve limestone car-

[7] Idem.

ries the best rock for lime and cement; the white oolite beds utilized for such purposes elsewhere are the most desirable. Such oolite beds constitute a large part of the entire limestone stratum.

The main areas of outcrop of the Ste. Genevieve within the territory here described are a long strip at the north base of Wildcat Hills, in secs. 27 and 28, T. 9 S., R. 8 E., and another similar strip in the fault block just west of Horseshoe Gap, in secs. 25 and 26, T. 9 S., R. 7 E. In the first described area it is exposed at the salt spring in the SW. ¼ sec. 26, T. 9 S., R. 8 E., and at the mouth of a ravine just southeast of the center of sec. 28, of the same township. No good exposures were found in the western strip, but there is an abundance of debris carrying the diagnostic *Platycrinus penicillus* stem plates on the slopes and in the ravine in the NE. ¼ sec. 35, T. 9 S., R. 7 E. The dip is rather steep, 40° or more to the south, but probably quarry sites could be found at which considerable rock could be won economically.

The Clore and Kinkaid formations include beds of limestone of sufficient thickness and apparently of sufficient purity to be profitably exploited for agricultural lime. There are large areas of outcrop at the north end of and along the west slope of Cave Hill. See section, p. 36. Probably the limestone beds Nos. 2, 6, 8, and 12 of this section would be suitable for fertilizer. Doubtless many places could be found on the slopes of Cave Hill where quarries could be profitably operated in these limestones. The dip generally is not over 15 to 20° to the east or southeast, as shown by the structure sections B-B′ and C-C′ of the detail map, Plate II.

The Menard limestone would be serviceable for fertilizer and other purposes wherever it is accessible in the region. There is a small area exposed on the axis of the Horton anticline. Much of the St. Louis limestone would be suitable for agricultural lime and for crushed rock, but most of it is too siliceous for the manufacture of lime or cement.

No chemical analyses have been made of these limestones in this region, but from analyses from other regions the oolite of the Ste. Genevieve is known to be of a high grade, and as the formation here preserved all of its outward characteristics shown elsewhere where it has been tested, the conclusion is justified that here also it is of high grade.

Chert for Road Metal

In addition to its many limestone formations, which would afford crushed stone for road metal, this area has a considerable reserve of excellent road metal in the chert of the Osage limestone in the knoll half a mile northwest of Horseshoe Gap. The dip here is steep, nearly vertical, which would be a factor in the expense of quarrying. A good body of rock, however, stands above the valley level, so that a quarry would be self-draining.

No tests of this material have been made, either in actual use or in the laboratory, but in a few places in the vicinity of the Hicks dome, in Hardin County, where roads are located upon it on the ridges, or for short distances in the valleys near the base of the ridges, the ability of the material to maintain a hard, smooth surface on the road is amply demonstrated.

Shale

Shale for brick and cement could doubtless be had in quantity from the Tradewater, Carbondale, and McLeansboro formations.

Sand

The extensive deposits of sand along the northwest slope of the Shawneetown Hills and in the area of drifted sand to the southwest would probably furnish large quantities of excellent sand for mortar and concrete.

Oil and Gas

Several deep wells have been drilled in this region without reporting any show of oil or gas. A well was drilled in the vicinity of Mud Lake, in the southeast corner of the area, another at Shawneetown, and another about 4 miles west of Equality. Several deep diamond drill borings were made for coal in Eagle Valley and north of the Shawneetown Hills, and other deep wells to the north of the area.

While at any of these localities sandstone strata of Mississippian or Pennsylvanian age exist to depths of 2000 feet or more, the geologic structure is not favorable, being either synclinal, as in Eagle Valley, or gently and uniformly dipping, as north of the Shawneetown Hills.

The only locality where the structure is favorable is in the southwest part of Saline County along the axis of the Horton Hill anticline. Beneath this region are the lower sandstones of the Chester group and still lower horizons at which oil occurs elsewhere in the State, as the McClosky and Colmar horizons. On the whole, however, in view of the general geological conditions and in the light of past experience, the prospects for oil or gas in this region are not particularly favorable.

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STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
A. M. SHELTON, DIRECTOR

STATE GEOLOGICAL SURVEY DIVISION

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M. M. LEIGHTON, CHIEF

GEOLOGIC MAP OF EQUALITY–SHAWNEETOWN AREA

(PARTS OF GALLATIN AND SALINE COUNTIES)

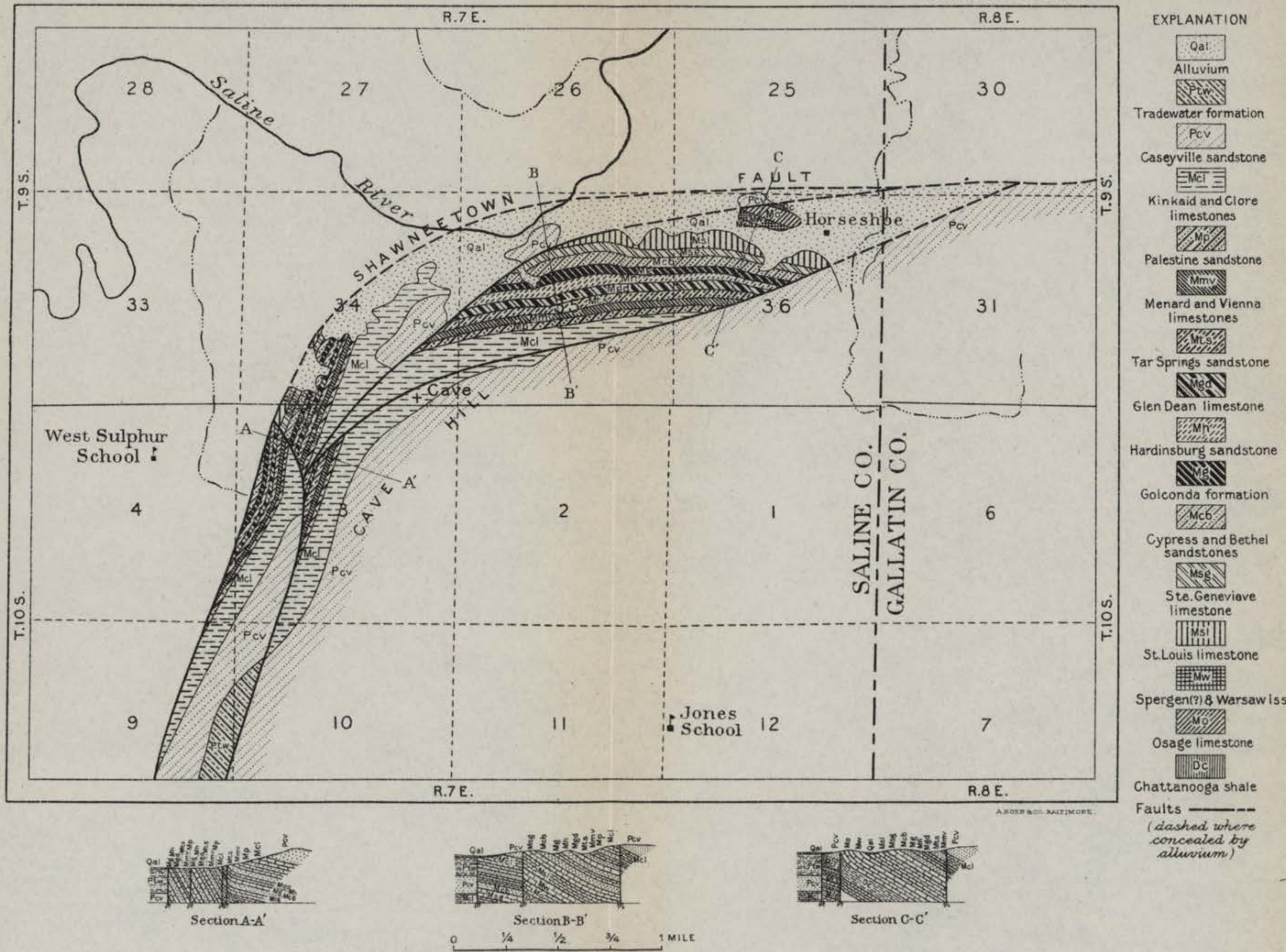
ILLINOIS

BY CHARLES BUTTS

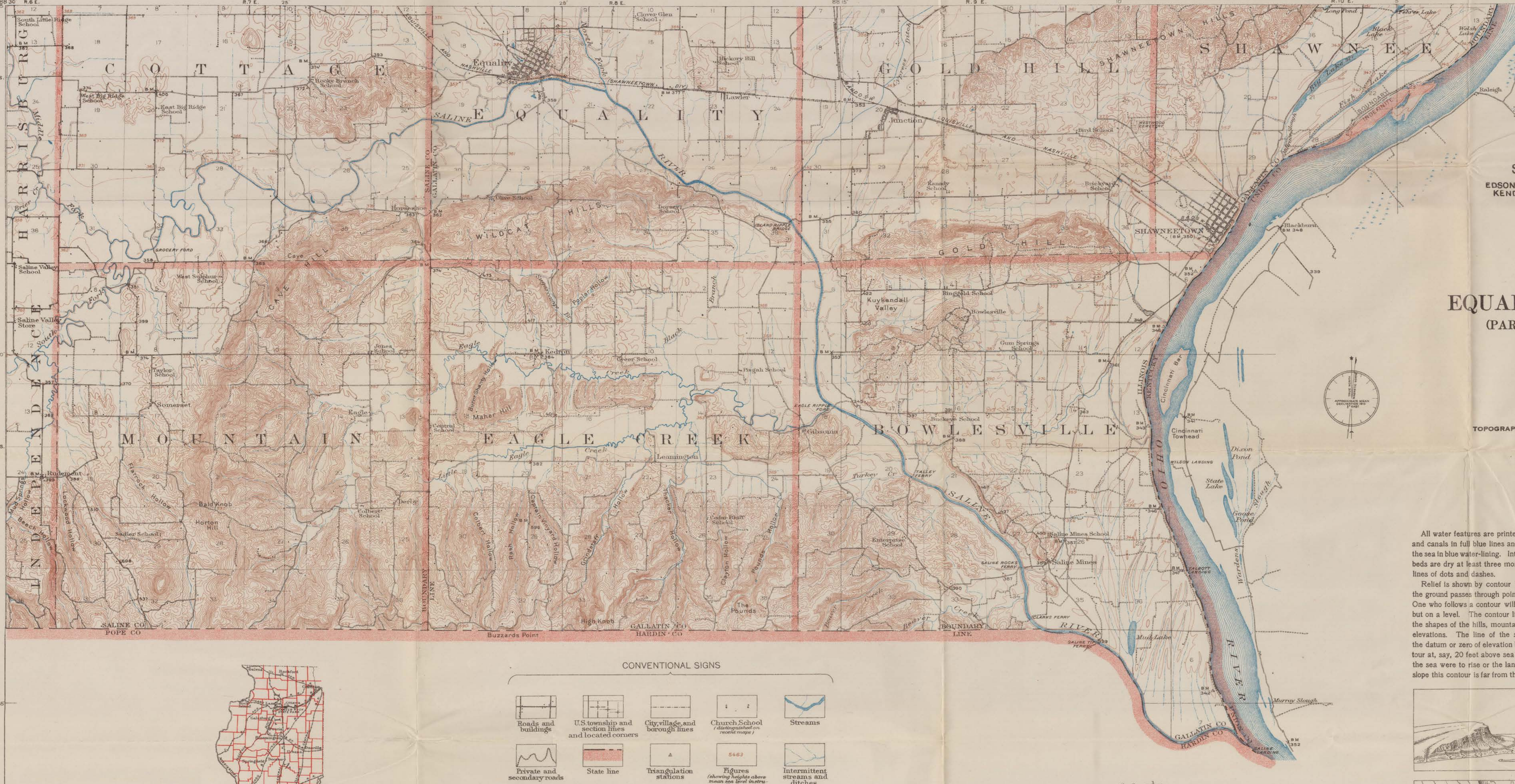
SURVEYED IN COOPERATION WITH
U. S. GEOLOGICAL SURVEY
TOPOGRAPHIC MAPPING IN 1913-1914 GEOLOGIC MAPPING IN 1917-1918
PUBLISHED IN 1925

Scale $\frac{1}{62500}$

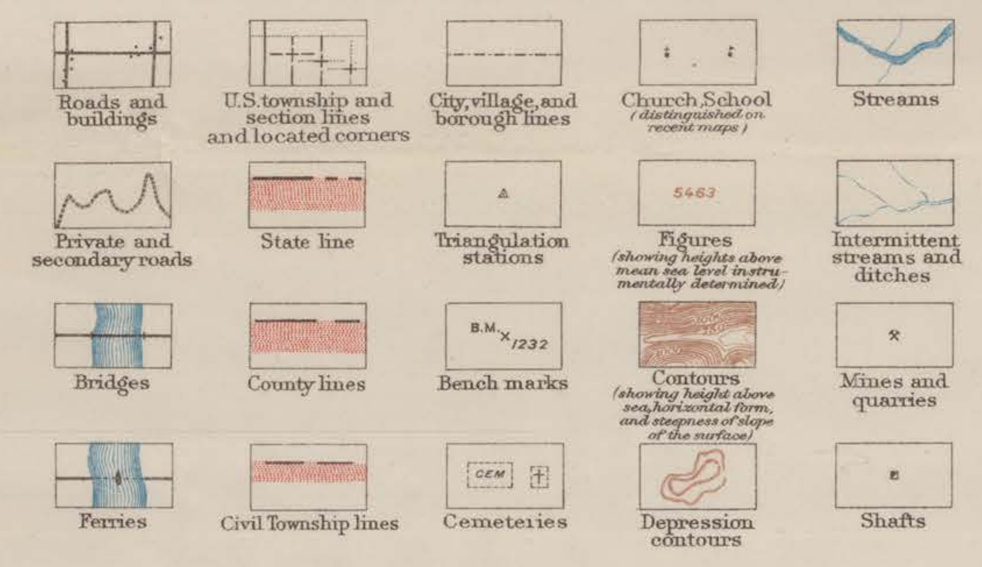
Contour interval 20 feet.
Datum is mean sea level.



GEOLOGIC AND CROSS-SECTIONS OF THE FORMATIONS IN THE FAULT BLOCKS AT THE NORTH END OF CAVE HILL



CONVENTIONAL SIGNS



Scale 1/62500

Contour interval 20 feet.
Datum is mean sea level.

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TOPOGRAPHIC MAP OF EQUALITY—SHAWNEETOWN AREA (PARTS OF GALLATIN AND SALINE COUNTIES) ILLINOIS

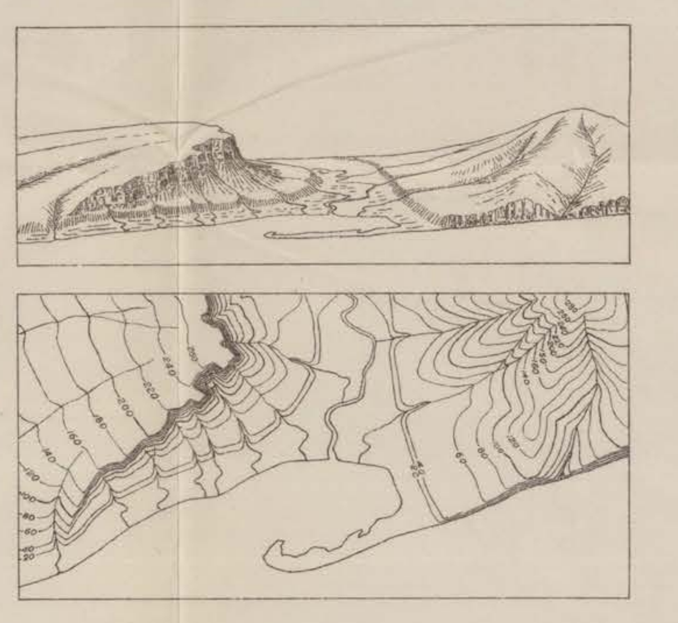
SURVEYED IN COOPERATION WITH U. S. GEOLOGICAL SURVEY

TOPOGRAPHIC MAPPING IN 1913-1914 PUBLISHED IN 1925

EXPLANATION OF TOPOGRAPHIC MAP

All water features are printed in *blue*, the smaller streams and canals in full blue lines and the larger streams, lakes, and the sea in blue water-lining. Intermittent streams—those whose beds are dry at least three months in the year—are shown by lines of dots and dashes.

Relief is shown by contour lines in *brown*. A contour on the ground passes through points that have the same altitude. One who follows a contour will go neither uphill nor downhill but on a level. The contour lines on the map show not only the shapes of the hills, mountains, and valleys, but also their elevations. The line of the sea coast itself is a contour line, the datum or zero of elevation being mean sea level. The contour at, say, 20 feet above sea level, would be the shore line if the sea were to rise or the land to sink 20 feet. On a gentle slope this contour is far from the present coast; on a steep slope it is near the coast. Where successive contour lines are far apart on the map they indicate a gentle slope; where they are close together they indicate a steep slope; and where they run together in one line they indicate a cliff.



The manner in which contour lines express altitude, form, and grade is shown in the figure below.

The sketch represents a river valley between two hills. In the foreground is the sea, with a bay that is partly inclosed by a hooked sand bar. On each side of the valley is a terrace into which small streams have cut narrow gullies. The hill on the right has a rounded summit and gently sloping spurs, separated by ravines. The spurs are truncated at their lower ends by a sea cliff. The hill on the left terminates abruptly at the valley in a steep scarp. It slopes gradually back away from the scarp and forms an inclined table-land, which is traversed by a few shallow gullies. On the map each of these features is indicated, directly beneath its position in the sketch, by contour lines.

The contour interval, or the vertical distance in feet between one contour and the next, is stated at the bottom of each map. This interval differs according to the character of the area mapped; in a flat country it may be as small as 5 feet; in a mountainous region it may be 250 feet. Certain contour lines, every fourth or fifth one, are made heavier than the others and are accompanied by figures stating elevation above sea level. The heights of many points, such as road corners, summits, surfaces of lakes, and bench marks, are also given on the map in figures, which express the elevations to the nearest foot only.

The works of man are shown in *black*, in which color all lettering, also is printed. Boundaries, such as those of a state, county, city, land grant, township, or reservation, are shown by continuous or broken lines of different kinds and weights. Public and through roads are shown by fine double lines; private and poor roads by dashed double lines; trails by dashed single lines.

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